ST. LOUIS LAMBERT INTERNATIONAL AIRPORT®

AIRPORT MASTER PLAN

CHAPTER 11 - FACILITY CONDITION ASSESSMENT

VOLUME I – GENERAL REPORT

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TERMS AND EQUIVALENTS

Facility(ies): The terminal and concourse buildings in their entirety, including the supporting climate control building and tunnels.

Terminal 1 / Main Terminal: The headhouse containing ticketing, baggage claim, and Airport support functions outside of security but connected to Concourses A, B, C, and D.

Terminal 2 / East Terminal: The headhouse containing ticketing, baggage claim, and Airport support functions outside of security but connected to Concourse E.

CONDITION RATING SCALE

RATING	EVALUATION	STANDARD
5	Excellent	New or like new condition with no observable defects.
4	Good	Element performs intended function with high degree of reliability and/or effectiveness.
3	Fair	Element performs intended function with small reduction in reliability and/or effectiveness.
2	Poor	Element performs intended function with significant reduction in reliability and/or effectiveness. Repair or replacement may be required.
1	Unsatisfactory	Element does not perform intended function at an acceptable level of reliability and/or effectiveness. Repair or replacement is required.

ACTION PRIORITY SCALE

PRIORITY	ORGANIZATION
1	High Priority: Safety and operational requirements
2	Strongly Recommended: Non-critical facility maintenance
3	Prudent: Low priority improvements and preventive maintenance

11 FACILITY CONDITION ASSESSMENT

St. Louis Lambert International Airport Authority (STLAA) is in the process of updating long range airport plans. To achieve the goals and objectives of the activities related to passenger terminal, concourse, and supporting infrastructure planning, more detailed condition assessment data is required by STLAA. An assessment of building systems and infrastructure that serve the facilities is needed, particularly since some systems are approaching the end of their expected serviceable life and the Airport incurs significant annual costs maintaining the facilities.

The objective of this Facility Condition Assessment (FCA) is to assess the condition of the facilities through the following steps:

- Collect information from select maintenance records, STLAA staff knowledgeable of the systems, site inspections, and assessment of the physical condition of component systems that make up the Airport Facilities,
- Estimate the effective remaining useful life of component systems, if any,
- Establish a benchmark to compare the relative condition of component systems, and
- Recommend repairs, replacement and improvements to the system components and estimate the costs of the recommendations over the 15-year study period.

The Airport facilities in this study include Terminal 1, Terminal 2, and associated Concourses A, B, C, D and E, the East and West Climate Control Facilities, the arrival and departure roadways and associated elevated bridges, the parking garages that are adjacent to Terminals 1 and 2, and the East and West Electrical Substations.

The study provides an in-depth assessment of various components of the facility systems following the CSI UniFormat classification system characterized by their functions including:

1. Substructure - Foundations & slabs on grade
2. Shell - Superstructure and exterior closures
3. Interiors - Interior construction, finishes, building code, and, space and functional issues
4. Services - Conveying Systems (Elevators, escalators and moving walkways), HVAC, plumbing, fire protection, electrical, communication and security
5. Equipment - Baggage handling systems
6. Roadways - Surface pavements, and bridge deck and supporting structures
7. Stormwater pump stations

The FCA follows guidelines in ASTM E2018-01 “Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process”. The FCA Team consisted of St. Louis area consultants with experience related to the systems each was assigned to assess. The team included:

- WSP USA (WSP): Team Leader, Architecture and Structural, Mechanical, and Electrical Engineering
- Engineering Design Source, Inc. (EDSI): Structural, Civil Engineering

- Faith Group, LLC (FG): Security/IT Infrastructure Engineering
- M3 Engineering Group (M3): GIS/CAD management, Stormwater Pump Assessment
- Cage, a division of Ross & Baruzzini (Cage): Baggage Handling System

The FCA team followed a methodical procedure to collect data, observe physical conditions, document observations, assess conditions and report assessments through the following general procedure:

- Collect and review available record data
- Observe facility systems on site and establish preliminary assessments
- Discuss facility conditions with knowledgeable Airport staff
- Conduct follow-up site visits
- Refine assessments and develop recommendations
- Estimate repair and replacement costs
- Establish condition indices and recommendation priorities

A condition rating scale of one to five representing conditions of Unsatisfactory/Poor/Fair/Good/Excellent was used by all assessors for consistency. The condition rating was used by inspectors to make preliminary assessments of the condition of specific equipment and construction elements observed during the facility site visits and adjusted based on subsequent input. Some individual building elements were rated unsatisfactory in initial assessments, but due to ongoing building maintenance and the variety of condition rating for individual elements, few composite elements were rated unsatisfactory.

The following assessments summarizes each building system and is further detailed in the report and supporting tables.

Substructure

A visual evaluation was performed on visible structural elements, while other building components, such as architectural finishes, were observed where the structural members were hidden in walls or clad. These finish components can show distress indictive of structural issues. Key structural elements observed included, concrete slabs-on-grade, columns, beams, floor systems, and roof trusses.

- Most building structural components are in fair or good condition except for the Terminal 1 parking garage which is in poor condition (RUL 5-10 years provided the repairs to the structure are made)
- Terminal 1 Garage poor condition is mainly caused by issues with the expansion joints throughout the garage which are allowing water infiltration into the lower floors as well as into the concrete structural members and resulting in corrosion of the steel reinforcement and delamination of the concrete at various columns, beams, and slabs
- The terminal and concourse structural components that are most often in poor condition are the concrete slabs at the apron levels and at the exterior adjacent to the buildings, and the tunnel structures
- Concourse D has a few locations where the subgrade mechanical room stem walls are leaning inward and causing fracturing and separations between the concrete and the CMU exterior partition walls
- Overall, the majority of the structural elements are in fair to good condition with a remaining useful life beyond 10 years provided that routine maintenance is performed

Shell and Interiors

The exterior envelope for all the terminal and concourse buildings range from fair to good condition, but with specific conditions that require attention.

- The overall terminal and concourse buildings, while showing signs of age, also show the signs of a fervent maintenance program appropriate for keeping an aging facility in functionally sustainable condition and presenting a positive public image
- The interior conditions range from poor to good, depending on the area. In general, all the terminal and concourse public spaces are in very good condition
- Any interior public space issues stem from an exterior weakness mostly due to aging systems, i.e. roof leak, skylight leak, etc.,
- The apron level, due to areas no longer in use, ranges from poor conditions in the vacant areas to good/fair condition in the tenant operated gate and apron service/support areas

Services - Conveying

Conveying equipment analyzed includes elevators, escalators, moving walks, wheelchair lifts, and bag lifts.

- Systems are generally maintained in a fair condition.
- Many elevators and escalators are nearing the end of, or have exceeded, their useful life.

Conveying terms and equivalents are defined below:

- Modernization: to upgrade older controls systems, door operation, signal fixtures, and cab interiors

of elevators.

- Overhaul (elevators): thorough examination of all components of an elevator, excluding components included in modernization, and repairing/replacing components as needed.
- Overhaul (escalators and moving walkways): thorough examination of all components of an escalator or a moving walkway and repairing/replacing components as needed.
- Deep clean (escalators and moving walkways): taking a unit apart and thoroughly cleaning its components.

Services – Mechanical(HVAC), Plumbing & Fire Protection (MPFP)

Visual observations and preliminary assessments were made of accessible large equipment, and representative samples of smaller equipment and distributed systems. In the terminals and concourses, items inspected include HVAC air handlers, pumps, heat exchangers, piping and ductwork, plumbing water heating equipment, piping and fixtures, and fire protection sprinklers, piping, valves and hose cabinets. In Climate Control plants, items inspected are the large central equipment and distribution piping systems. Data collected is then reviewed and compared with information from existing records, airport staff, and previous reports.

- Generally, MPFP systems are maintained in a fair condition suitable to serve their intended purpose
- Capital improvements have been made over time and are in progress to maintain systems functional and maintainable
- Systems in the public areas on the Concourse and Ticketing levels of the terminals and concourses are in a better condition than those in non-public areas on the apron levels
- HVAC systems are in fair to good condition on the concourse and ticketing levels, and fair to poor condition on the apron levels but the unsatisfactory equipment is typically in or serving vacant areas
- Plumbing systems are found to be in good condition in the actively used passenger facilities on the concourse and ticketing levels
- Plumbing systems on the apron level and in vacant areas of Concourse C extension are in poor condition, and some are unsatisfactory and unusable
- Major renovations to the airport would require terminal and concourse areas to be protected throughout with automatic sprinklers
- Fire suppression piping in Terminal 1 and concourses A through D has interior corrosion that results in localized pipe leakage which will eventually require all existing fire suppression piping to be replaced

Services - Electrical

The electrical assessment includes an evaluation of lighting, normal power distribution, emergency power distribution and lightning protection.

- In general lighting systems in the public areas of the airport are in good condition, lighting in non-public areas is in poor to fair condition.
- The power distribution system is generally in fair to poor condition, largely due to age. Except for Concourse E/Terminal 2, the equipment installed during initial construction is between 35 and 64 years old.

- Lightning protection systems were only observed on the two terminal buildings and Concourse E. Neither systems are compliant with NFPA 780 requirements
- The overall age of the power distribution system is the biggest observation of concern

Equipment - Baggage Handling Systems

The T1 and T2 outbound and inbound baggage system assessment includes the Checked Baggage Inspection System/ Checked Baggage Resolution Area (CBIS/CBRA) and the motor control/distribution panels (MCPs) that control and provide power to the system.

- Overall, the T1 system is in good condition and had minor issues across the system. The estimated remaining useful life of the T1 system is between 10 and 15 years
- Overall, the T2 system is in good condition but is evident the system is more heavily used compared to the T1 system. The estimated remaining useful life of the T2 system is between 8 and 12 years
- The baggage control room is in good condition and well maintained. The controls, graphics, and reporting systems are all performing well. The upper level control room systems are estimated to have another 2-3 years before the hardware becomes obsolete or incompatible with existing equipment

Roadways and Bridges

The Terminal 1 (T1) and Terminal 2 (T2) Arrivals/Departures roadways and bridges along with Lambert International Boulevard (LIB) were assessed in the field and by review of available documents, plans, reports, and other information provided by STLAA staff. Individual assessments were developed for the roadways (entry and exit) and structures (arrivals, and departures and ramps) for T1 and T2, as well as roadways and bridges along LIB.

- The LIB over Coldwater Creek Bridge is currently in the design process for rehabilitation. Based on the current rehabilitation scope, the anticipated remaining useful life of this bridge exceeds 10 years.
- Terminal 1 Roads and Bridges are in poor condition with an overall Remaining Useful Life (RUL) of less than five years.
- Overall condition of Terminal 2 Roads and Bridges is fair.
- LIB Roads and Bridges' overall condition is fair with an estimated RUL greater than five years.

Stormwater Pump Stations

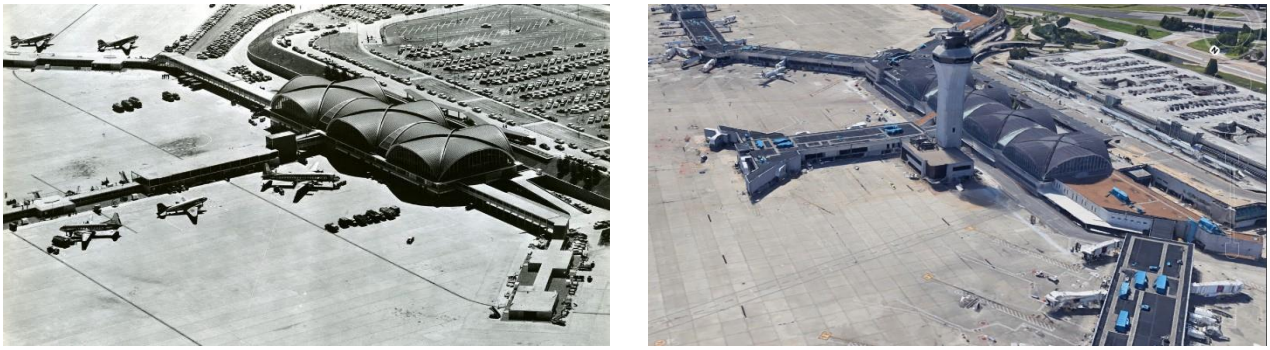
The stormwater pump station is located outside of Terminal 2 adjacent to the Terminal 2 loading dock.

- The purpose of the stormwater pump station, per technical experts at the Airport, is to convey stormwater to prevent flooding on MoDOT right-of-way
- The primary stormwater pumps are 22 years old and only have 3.5 hours of run time over the 22-year life and receive regular maintenance. The limited amount of pump run times are assumed to be maintenance run time
- The remaining useful life of these pumps is greater than 10 years
- The remaining useful life of the dewatering pump is 1-5 years with a spare pump stored on site

11.1 General Information

The central hub of Terminal 1 was constructed in 1956, and the airport terminal and concourse facilities expanded from that hub as shown in **Figure 11.1-1**. A rough chronology of the airport facility development is as follows:

Figure 11.1-1: STL Aerial Terminal 1 1950s and 2020



Source: STLAA, 2018.

1956 - Minoru Yamasaki's iconic arched terminal opened. Its modular design provided for later expansion.

1959 - Lambert became one of the first U.S. airports with jet airline service when Trans World Airlines began operating the groundbreaking Boeing 707.

1960s - added a new parallel runway and expanded the terminal facilities to accommodate the increasing demand.

1965 – Fourth dome added to the main terminal.

1971 - The airport became Lambert-St. Louis International Airport.

1972 - TWA began wide body service to Lambert with the Boeing 747 and Lockheed 1011.

1977 – Concourses A & C rebuilt into bi-level structures with boarding bridges.

1977 - the Federal Aviation Administration concluded that Lambert should be expanded and upgraded to meet anticipated future needs.

1982 - TWA made Lambert its principal domestic hub / Concourse C Extension constructed.

1985 - Lambert constructed Concourse D, bringing capacity to 81 gates / Southwest Airlines began serving Lambert, and TWA inaugurated non-stop international flights from St. Louis to Paris, London and Frankfurt.

1998 - the FAA endorsed the W-1W runway expansion alternative / Lambert opened the East Terminal (Terminal 2)

2006 - New W-1W runway 11 – 29 opened.

2008 – Airline operations in Concourses B and D were discontinued after American Airlines closed its STL hub.

2001 - American Airlines merged with TWA.

2011 - the Good Friday Tornado struck Lambert. The eastern end of Concourse C was closed.

11.1.1 Purpose

A robust condition assessment is required to achieve the goals and objectives of the ALP for planning scenarios related to passenger terminal alternatives. An evaluation of the exterior closure and superstructure, interiors, services, pump stations, special systems, bridges and roadways (collectively referred to as the Systems) that serve the Facilities is needed, particularly, as some are approaching their end of serviceable life and STLAA has experienced significant costs year over year in maintaining the Facilities.

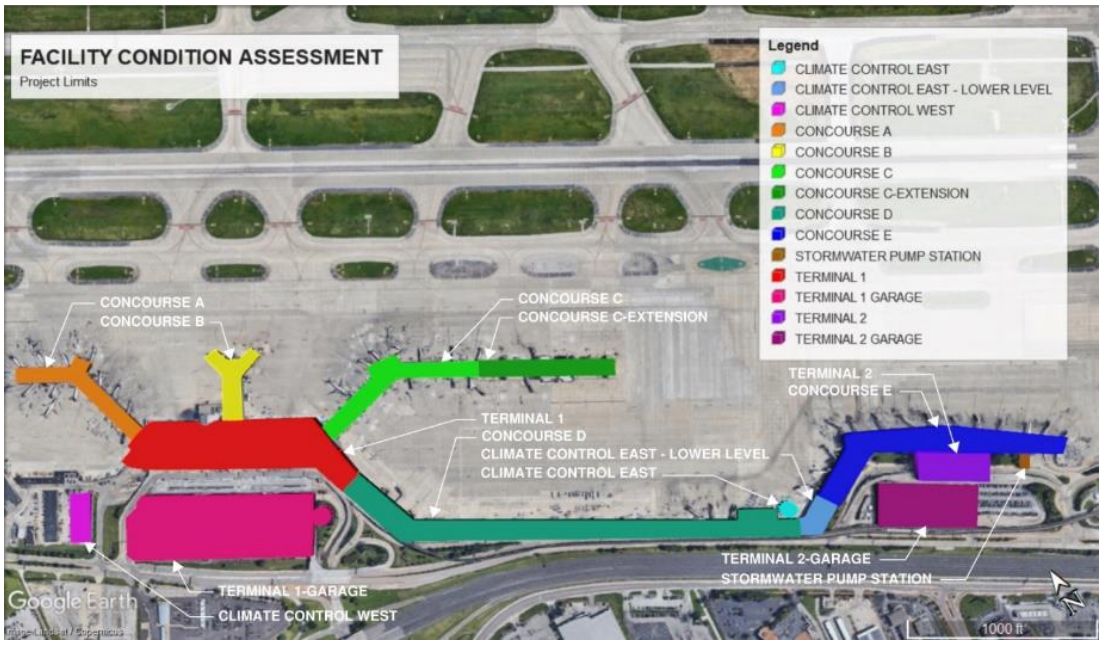
The goals and objectives of the FCA shall be to assess the condition of the Facilities and to:

- Collect information, review select maintenance records, interview and conduct site assessments STLAA staff knowledgeable of the systems, and assess the physical condition of the component systems making up the facilities
- Define the effective Remaining Useful Life (RUL) of the component systems of the facilities
- Recommend repairs, replacement and improvements to the system components and forecast future expenditures within a fifteen-year window
- Estimate the costs of the recommendations

11.1.2 Scope

The FCA study provides an in-depth assessment of various components of the terminal and concourse facility. The St. Louis Airport Facilities assessed in this study, herein after referred to as the “Facilities”, include Terminal 1, Terminal 2, and associated Concourses A, B, C, D and E (but excluding passenger boarding bridges), the East and West Climate Control Facilities, the arrival and departure roadways and associated elevated bridges, the parking garages that are adjacent to Terminals 1 and 2, and the East (International) and West (Lambert) Electrical Substations. The boundaries of the assessment are illustrated in **Figure 11.1-2**. General sitework, including underground utilities, were not assessed.

Figure 11.1-2: Project Limits



Source: WSP USA, 2021.

The assessment includes:

1. Superstructure: suspended floors and roof systems
2. Exterior closure: building envelope including walls, roof, doors, and fenestration
3. Interiors: building code and ADAAG compliance, finishes, built-in casework and similar construction, and, space and functional issues
4. Services: HVAC, plumbing, fire protection, electrical, communication, vertical transportation, and moving walkways
5. Stormwater pump stations
6. Special Systems: Baggage handling systems (BHS) with consideration for redundancy.
7. Roadways: surface pavements, and bridge deck and supporting structures

Limited assessment was performed on some components, such as:

1. Signage was assessed for condition only and not for suitability or effectiveness. The structural mounting of overhead signage was assessed as a structural element
2. Tenant spaces were assessed for the airport infrastructure and in their entirety as a space that will revert to airport control if the lease is not renewed. The Airport advised that tenants are responsible for installation and maintenance of all finishes, equipment, HVAC, and plumbing within their space. The Airport is responsible only for utilities into and out of the space, and the building structure

Various components were excluded from the FCA, as follows:

1. The FAA offices
2. The FAA control tower
3. Movable furnishings and equipment
4. Airline equipment and systems

5. Aircraft servicing equipment including passenger boarding bridges and glycol handling

Note that Communications & Security Systems Assessment are within the scope of the Facility Condition Assessment. However, due to the sensitive nature of the information that is controlled under 49 CFR parts 15 and 1520, findings and recommendations for Communications and Security Systems are provided to STLAA in a separate volume ***(Refer to Volume 2 – Communications Report)***.

11.1.3 Methodology

The FCA was generally conducted in accordance with ASTM E2018-01 "Standard Guide for Property Condition Assessments: Baseline Property Condition Assessment Process". The FCA Team, shown in **Table 11.1-1**, consisted of St. Louis area consultants with experience related to the systems each was assigned to assess. The team included:

Table 11.1-1: FCA Team by firm's responsibility

FIRM	RESPONSIBILITY
WSP USA (WSP)	FCA Coordination, Architecture and Building Structural, Mechanical and Electrical Engineering
Engineering Design Source, Inc. (EDSI)	Bridge Structural, Civil Engineering
Faith Group, LLC (FG)	Security/IT Infrastructure Engineering
M3 Engineering Group (M3)	GIS/CAD management, Stormwater Pump Assessment
Cage (A division of Ross & Baruzzini)	Baggage Handling System

The FCA team followed a methodical procedure to collect data, observe physical conditions, document observations, assess conditions and report assessments and recommendations as described herein.

- **Data Collection:** Informative data such as Drawings and Reports made available previously by STLAA were reviewed, and additional detailed reports and data was requested for the FCA. Any additional data, drawings and reports received for the "FCA" were compiled as a supplement to the original ALPU Inventory of Existing Conditions. STLAA provided studies by others for select systems for consolidation into the FCA report. A listing of the references used as part of this assessment is included in Appendix 11D to the report.
- **Observations:** Visual observations were conducted of accessible facility systems and large equipment over a two-week period by experienced discipline specific engineers and architects. For systems and equipment not easily accessible from the floor, observations were collected from the best available accessible location, or STLAA staff resource. Inspection was for evaluation of existing conditions relative to its current application, and not for general code compliance. However, where potential conflicts with current code requirements were evident, such issues were noted. Visual observations did not include selective demolition of walls, floors, or ceilings to access Facility components, or any destructive testing, general testing, extensive probing and confined space

entry. The observation methodology for each component is summarized in **Table 11.1-2.**

The following Facilities and components were assessed:

a. **Terminal 1 & Concourses A, B, C, and D, and Terminal 2**: including Concourse E, excluding passenger boarding bridges.
    i. Substructure (where accessible)
    ii. Shell
    iii. Interiors
    iv. Services (HVAC, Building Automation System, plumbing, fire protection, electrical, and IT/Communications/Security)
    v. Equipment (Baggage Handling Systems)
    vi. Stormwater pumps (at T2 loading dock)

b. **T1 Roadways & Bridges:** arrivals and departures including curbside drives, associated bridges and surface structures connecting to LIB.
    i. Superstructure
    ii. Site Improvements (including structural components of truss mounted signs)
    iii. Services (Electrical / Lighting)
    iv. Building Code (including ADAAG)

c. T1 and T2 Garages
    i. Superstructure observations to confirm prior assessments by others.
    ii. Services including mechanical HVAC, plumbing, fire protection, and electrical power and lighting.
    iii. Assessments by others (including necessary probable cost estimates of repairs, and/or replacements)

d. **East and West Climate Control** Energy Plants: specifically, for the boilers, deaerators, chillers, cooling towers, pumps, switchgear, and standby generators
    i. Superstructure
    ii. Exterior closure
    iii. Climate Control systems (including mechanical, plumbing and electrical)

Table 11.1-2: Observation Manner by Component

COMPONENT	MANNER CONDUCTED
Superstructure	A sampling of accessible members, and a review of record drawings.
Exterior closure	Visual observation from the ground and walking the roof.
Interiors	Visual evaluation of the condition of interior finishes with no aesthetic bias, and limited assessment of code compliance.
Conveying	Interviews with airport and contract maintenance staff knowledgeable of the systems; review of prior reports and maintenance records.
MEP	Visual observation of the condition of mechanical, electrical and plumbing equipment and distribution systems, interviews with knowledgeable Airport staff, and review of prior documentation.
Security/ Technology	Visual observation of the condition of mechanical, electrical and plumbing equipment and distribution systems, interviews with knowledgeable Airport staff, and review of prior documentation.
Large central equipment	Visual observations of accessible major components; minor assets (25% sampling) assessed on a system level.
Baggage Handling Systems	Visual observation of the condition of mechanical, electrical and plumbing equipment and distribution systems, interviews with knowledgeable Airport staff, and review of prior documentation.
Roadway	Review of prior condition assessment reports and a visual observation of current conditions (up to and including the immediate intersections with Lambert International Blvd.).

Note:

[1] Visual observation data was collected on specific elements of facility systems within individual rooms, or groups of rooms, identified by door numbers. Some spaces, such as smaller rooms in suites, tenant spaces, and gate hold rooms, that were all in a similar condition were grouped and recorded together rather than entering repetitive entries. Door numbers used for identification generally followed Airport labeling. In this report, the Main Terminal (MT) is referred to as T1, and the East Terminal (ET) is referred to as T2, but door numbers may reflect legacy labeling such as MT and ET.

- **Interviews:** In-person interviews were conducted with current STLAA staff knowledgeable of the Systems also referred to as Subject Matter Experts (SMEs). Interviews were conducted following the initial visual observations of all Facilities covered by the FCA to allow the assessment team to put comments received in context with preliminary observations. Follow-up and supplemental

visual observations were scheduled and conducted by discipline specific engineers and architects of accessible Facility systems as indicated by input received from the SME's.

- **Assessment Ranking:** Conditions of Terminal component facilities and major systems were ranked on a scale of one to five (see **Table 11.1-3**), based upon visual observations of the professional performing the observation, age, verbal reports from STLAA SME's, and system type. Specific component assessments were aggregated to establish composite system and Facility condition rankings.
- **Remaining Useful Life Analysis:** Remaining useful life of component systems were estimated and recommendations for capital improvements were prepared to support the Airport's 5-year and 10-year Capital Improvement Program (CIP) within the study period.
- **Probable Cost:** The rough order of magnitude of probable costs was estimated for the recommended improvements to bring systems up to a sustainable condition.
    a. Planning level cost estimates in this study are based on 2020 dollars, and include prime contractor mark-up, a 10% engineering allowance, a 5% supervision and administration allowance, and a 20% contingency appropriate for a planning study.
    b. Replacement costs are estimated for comparison with repair costs to establish condition indices as a planning indicator.
    c. Appropriate escalations and contingencies are applied to costs.
- **Prioritization:** A priority ranking of recommended improvements was established to guide capital planning to meet Airport Layout Plan Update objectives.
- **Additional Consideration:** Options for supplemental forensic testing and inspection were evaluated near the end of data collection and at the beginning of data assessment, and a list of suggested testing was prepared for review with the STLAA. Following discussion with the STLAA, a short list of supplemental investigations was identified for implementation.
    a. Supplemental structural assessment – Concourse D foundation evaluation
    b. Fire sprinkler testing
    c. Transformer testing

11.1.4 Assessment Guidelines

RATING SCALES

A condition rating scale of one to five as shown in **Table 11.1-3** was established and used by field assessors for consistency. The condition rating scale was selected to allow assessors reasonable flexibility in evaluating existing conditions while retaining simplicity for consistent assessments by various reviewers.

Although STLAA maintenance departments, such as Climate Control, also used a five-point scale for previous assessments, it should be noted that condition assessments are subject to the assessor's perspective.

For the purpose of this condition assessment, assessors evaluated the age and condition of assets relative to the expected useful life of a similar new asset, whereas maintenance staff might assess assets relative to the condition of other similar assets installed on the same campus. Because of this perspective, the condition assessment team might rate a 10-year-old asset "fair" relative to its expected useful life from new, but maintenance staff might rate that same asset as "good" relative to other items they maintain. The condition rating to make preliminary assessments of specific equipment and construction elements were aggregated to establish condition rankings for composite systems and facilities. The evaluations were categorized with the defined standards as shown in Table 11.1-3.

Table 11.1-3: Condition Rating Scale

RATING	EVALUATION	STANDARD
5	Excellent	New or like new condition with no observable defects.
4	Good	Element performs intended function with high degree of reliability and/or effectiveness.
3	Fair	Element performs intended function with small reduction in reliability and/or effectiveness.
2	Poor	Element performs intended function with significant reduction in reliability and/or effectiveness. Repair or replacement may be required.
1	Unsatisfactory	Element does not perform intended function at an acceptable level of reliability and/or effectiveness. Repair or replacement is required.

Source: WSP USA, August 2020.

Assessments were made of building systems following a classification similar to the CSI UniFormat classification system. The UniFormat system is a method of arranging construction information based on functional elements, or parts of a facility characterized by their functions, without regard to the materials and methods used to accomplish them. These elements are organized by system components and sub-components. The observations of individual elements were rolled up to assessments on a building component and sub-component basis, and then rolled up to a composite condition assessment by building for planning purposes. An example of a portion of the component breakdown structure used is shown in **Table 11.1-4** to illustrate the assessment approach. A complete component classification as used in the FCA is included in Appendix 11A.

The assessment covered a wide range of elements with various equipment and structures included in the architectural, structural, site, mechanical, electrical, and security systems observed. Some of those elements date back to the original construction of the airport terminal in 1953, and many others have been replaced at different intervals over subsequent years. Consequently, facility components vary widely in age and condition as would be expected. The airport has also invested in maintaining a positive passenger experience, so public areas of the airport are generally in better condition than non-public, back-of-house, areas. Because of the wide variety of equipment, ages and conditions, elements in good condition tend to offset those in poor condition as element assessments are rolled up into systems. Likewise, the condition

of well-maintained public areas tends to offset the condition of non-public areas when building areas are grouped together. To present a fair representation of condition, assessment summaries include various component levels, and the apron and tunnel levels are separated from the ticketing and concourse levels for each building as applicable.

Table 11.1-4: Facility Component Classification System Example

(Refer to Appendix 11A for the Component Classification System as used in the FCA)

	COMPONENT CLASSIFICATION		
FACILITY	**COMPONENT SYSTEM**	**COMPONENT SUB-SYSTEM**	**ELEMENT**
Ex: Terminal 1	Substructure	Foundations	
		Subgrades Enclosures	CMU and CIP Walls
		Slabs on Grade	Floor Slabs
	Shell	Superstructure	Columns
			Floor Construction
		Exterior Vertical Enclosures	CMU and CIP Walls
			Exterior Walls
		Exterior Horizontal Enclosures	Roof Structure
			Horizontal Openings
			Overhead Exterior Enclosures

REMAINING USEFUL LIFE (RUL)

The condition assessment includes an estimate of the remaining useful life of facility systems as an indicator of condition and the investment required to maintain facilities in a sustainable condition, which is based on representative industry expected life of similar building systems or equipment. Depending on the conditions under which systems are installed and operated, systems may fail before the expected useful life, or continue to operate well beyond the expected life. Remaining useful life as used in this condition assessment is a subjective evaluation of the time remaining before significant capital improvements are required to maintain the system in a sustainable condition.

ACTION PRIORITY

Urgency of action (corresponds to condition rating, based on the assessor's professional evaluation)

- 1 High Priority: Safety and operational requirements
- 2 Strongly Recommended: Non-critical facility maintenance
- 3 Prudent: Low priority improvements and preventive maintenance

TABULAR ASSESSMENT

The Tabular Assessment in Appendix 11B represents the compiled assessment for each component system subdivided into component sub-systems and respective elements. The assessments featured in the table include the condition assessment rating and estimated remaining useful life of individual elements assessed.

11.2 System Descriptions and Observations

11.2.1 General Description and Recommendations

The following section provides a general description of the overall condition of each building system assessed as part of the FCA along with general line actions and recommendations to remediate the observed deficiencies. Detailed condition and recommendation by Airport Facility area are provided in the subsequent sections.

SUBSTRUCTURE

The substructure includes the airport foundations, tunnels, and apron-level slabs-on-grade. Based on available documentation and visual observations, the substructures of the airport range from good to poor. The visible portions of the foundations appeared to be in fair condition and distress consistent with foundation movement and/or foundation issues was isolated to few locations which will be addressed later in this report. The tunnels structures were in good condition at locations that were most recently constructed (e.g. Terminal 2, Concourse E). The tunnels beneath the older structures (e.g. Terminal 1, Concourse A) ranged from fair to poor.

Recommendations

- Repair locations of damaged concrete at the tunnels and floor slabs at the apron levels
- Concrete distress in the form of cracks/fractures, spalling/surface deterioration, and corrosion of the steel reinforcing in some areas. This distress should be monitored and repaired to prevent further deterioration and the potential of reduction in the load carrying capacity of the structural elements

SHELL

The overall shell condition of the airport ranges from fair to good condition. The roof system is well maintained except some potential leaking points on Concourse C, D, and E which will require further testing. In Concourse D, some of the skylight laminations are showing cracks. The window and mullion systems are in good condition. The exterior wall system is performing well with some evidence of normal deterioration.

Recommendations

- Repair the columns in Terminal 1
- Perform a roof core test to examine the extent of water transmission into the roof system on the Concourse B Extension, C Extension, Terminal D and Terminal E
- Test the skylights at C Extension, Terminal D and Terminal E
- Repair the steel members with corrosion at Concourse A and Concourse C
- Repair the façade from vehicle impact
- Provide a secondary drain system for future renovation

INTERIORS

The overall interior construction and finishes range from fair to very good condition. The concourse level of both terminals is in very good condition except some potential leaking through the dome structure of Terminal 1. Some vacant terminal locations (B Extension, C Extension) have stained floor finishes, including carpet, due to the leaks. The ceiling, wall and floor system are otherwise in good condition. The apron level condition ranges from poor to fair. Occupied areas function well as both office spaces and public areas. Office areas are in good condition with only some small leaks on ceiling. The public areas are in fair condition; a high level of finish is not required. The vacant areas of the apron level are in poor condition with failing ceilings and stained floors.

Recommendations

- No further maintenance is needed at this time at the concourse level except for some repair related to the ceiling leakage on Concourse B and the C Extension
- The apron level is performing well with only routine maintenance required
- Tests and repairs of the ceiling and floor systems are recommended for further renovation of the unused area (apron level of Concourse A, concourse level of the B Extension and the C Extension)

SERVICES

CONVEYING

Conveying systems throughout the facility include elevators, escalators, and moving walkways. These systems are maintained under a service agreement with Midwest Elevator. Conveying systems range in age from five to 45 years old. The life expectancy of conveying systems is about 25 years. Condition assessments and recommendations for these systems are based upon St. Louis Airport Authority (STLAA) and Midwest Elevator staff interviews.

STLAA staff report that all elevators need improvements in décor, cab lighting, and operating services. The most frequent problems with the elevators include continuous service calls for entrapment, luggage hitting the “call for assistance” button, and employees and tenants putting trash in the ceilings of non-public elevators.

STLAA staff report that all escalators need improvements in operating services and a deep cleaning.

Recommendations

- Modernize all elevators over 30 years old. Modernization includes upgrading controls systems, door operation, signal fixtures, and cab interiors
- Overhaul elevators older than 15 years old. Overhauling includes thorough examination of all components of an elevator, excluding components included in modernization, and repairing/replacing components as needed
- Overhaul escalators and moving walkways older than 15 years old. Overhauling includes thorough examination of all components of an escalator or a moving walkway and repairing/replacing components as needed
- Deep clean all escalators and moving walkways. A deep cleaning includes taking a unit apart and thoroughly cleaning its components

HVAC

Heating ventilating and air conditioning (HVAC) systems assessed throughout the terminal and concourses consist of central air and water distribution equipment, smaller distributed equipment, air and water distribution ductwork and piping, as well as system controls.

During the visual observations of the condition of HVAC equipment, preliminary assessments were made of accessible large equipment including air handlers, pumps, and heat exchangers. Representative samples of smaller equipment and distributed systems were observed and recorded as typical of such systems. Systems and equipment for which representative samples were observed include terminal equipment such as variable volume control boxes, fan-coil units, unit and cabinet heaters and door air curtains; unitary equipment such as computer room air conditioning, and stand-alone fans; steam, condensate and chilled water main and branch piping; air distribution ductwork and diffuser systems; and building automation and control systems (BACS).

Main steam, condensate return, and chilled water piping runs through the tunnels beneath the terminal. The physical condition of piping systems cannot be established based on visual observation alone, and assessment is based in part on STLAA reports of system conditions. This main piping appears and is reported to be in good condition, although some insulation is damaged or missing. Branch chilled water and steam condensate piping at connections to air handlers is commonly missing insulation, as illustrated in **Figure 11.2-1**. Where insulation is missing, chilled water piping is rusted, in some cases badly, due to condensation.

Air distribution systems are generally in good condition. With proper humidity control in the distributed air supply, duct systems can continue in use with only periodic cleaning. Airflow was noticed moving from one zone to another, particularly when some doors were opened, and a significant breeze was felt through the doorway. The airflow between zones is indicative of unbalanced air distribution and ventilation systems which can lead to temperature and humidity control problems, increased energy consumption and poor air quality.

Figure 11.2-1: Typical Air Handler Coil Piping Connections

Source: WSP USA, 2021.

Terminal and unitary equipment on the apron level is generally found to be in poor condition. This equipment typically has a shorter expected useful life that large central equipment. Located in mostly non-public areas, the terminal equipment on the apron level does not receive the maintenance attention that similar equipment in public areas might receive. Some of this equipment has failed or is operating beyond its expected useful life. Terminal and unitary equipment on the concourse and ticketing level is in better condition than that on the apron level. Door air curtains, shown in **Figure 11.2-2**, are typically functional but in poor condition. Computer room air conditioners (CRAC) located in IT and communication rooms are typically in good condition, but there is no redundancy for cooling in these critical rooms.

Figure 11.2-2: Representative Door Air Curtain in Terminal Entrance

Source: WSP USA, 2021.

On the apron level, some bird screens and filters on air intake louvers and bird screens on exhaust louvers from service areas are heavily coated with dirt and debris, as illustrated in **Figure 11.2-3**. Some bird screens

on outside walls and opening into baggage handling and similar service areas are almost completely obstructed, inhibiting airflow.

Figure 11.2-3: Fouled Air Filters Inhibiting Air Flow

Source: WSP USA, 2021.

Recommendations

- **Asset Management System**: Institute a formal Asset Management System using a web-based application or well documented internally generated software. The CityWorks program currently has over 6,000 STLAA assets logged and is used for work order tracking. In addition, the STLAA Climate Control Department has expanded the City Works data to include other information useful to asset management in an offline spreadsheet, but data currently recorded is inconsistent and may not include data relevant to effective asset management. The CityWorks system may be expanded for asset management, but other platforms may be better suited for the STLAA's needs. A well-organized asset management system provides a systematic approach to monitor, maintain and plan for physical assets within a facility. The plan should include a formal inventory of maintainable or replaceable assets that need upkeep and that need to be regularly changed. Facility managers should include in their formal inventory of facility assets anything that must be maintained annually, anything that has a significant replacement cost, and anything that would cause significant operational problems if it were to fail. The International Standard for Asset Management, ISO 55000, can be beneficial in implementing an asset management system and consists of three standards that specify an overview, principles and terminology, requirements, and application for the establishment, implementation, maintenance, and improvement of asset management program
- **Maintenance Management System**: Institute a formal Maintenance Management System using a web-based application or well documented internally generated software. An effective maintenance management program can be part of an asset management system and enables organizations to manage their entire repair and maintenance program from a centrally accessible dashboard. This type of software is designed to help organizations save time and money by properly managing their buildings and assets more efficiently and effectively. An organized maintenance management program also documents asset history and creates a consistent process that survives changes in management and personnel. The Cityworks program may also be useful as a maintenance

Recommendations

management system and is currently used by the Airport to place and track work orders, but the CityWorks software is GIS oriented and other platforms may be better suited to facility specific maintenance

- **Zone Pressure Testing**: Perform zone pressure testing relative to outdoors to establish building pressures and relative pressure between zones. Such testing will help identify air balancing and building pressurization problems that could be corrected with system air balancing to improve comfort and indoor air quality and reduce energy consumption. Open boarding bridge doors will interfere with relative pressure testing so it is recommended that the testing be performed at night
- **Select Repair and Replacement**: Institute a program to repair piping and replace insulation at the connections to heating and cooling coils on indoor air handlers and heating and ventilating units throughout the facility. Main distribution piping throughout the airport is reported to be in good condition despite some localized insulation damage. Insulation on piping and valves at end use equipment is typically in poor condition or non-existent. The lack of insulation has allowed moisture to corrode piping and appurtenances from the outside. Piping and valve assemblies at end use equipment throughout the facility should be systematically repaired and re-insulated. In addition, insulating these pipe assemblies using cellular elastomeric insulation for its durability and resistance to moisture damage is recommended
- **Redundant Cooling**: Install redundant cooling systems in IT and communication rooms. Most large IT and communication rooms are conditioned by a single computer room air conditioning unit, some of which may be supplemented with air from a central air handler. Some small communication rooms are conditioned with a single supply register from a central air handler. These communication rooms may contain systems critical to airport operations, and the air conditioning for these rooms should be reliable. It was reported that the communication rooms have a temperature alarm that alerts maintenance staff if the temperature in the room exceeds a preset maximum, but there is no provision for back-up air conditioning. It is recommended that a standby computer room air conditioner be installed in each IT and communication room
- **Air Curtain Replacement**: Institute a program for routine replacement of door air curtains, particularly at public entrances. This equipment would be expected to have a normal useful life of not more than 15 years, and those in public areas are subject to relatively high abuse. Planned improvements to entrances should include new door air curtains and consider raising the height of entrance vestibules to reduce contact with the ceiling and air curtains by the public
- **Screen and Filter Cleaning**: Institute a program to clean bird screens and filters on air intake and exhaust openings on the apron level, including those opening onto interior baggage handling or similar service areas. Most bird screens in observable outside air intake and exhaust louvers for general room ventilation are significantly obstructed with accumulated dirt and debris. Some bird screens are almost entirely plugged with accumulated debris. Based on the condition of screens that are observable, it is expected that all outside air intake and relief louvers are in similar condition. Blockage of intake and exhaust louvers reduces the ventilation airflow, reducing indoor air quality, increasing the static pressure in air distribution systems thereby increasing energy cost. These factors can all lead to increased equipment maintenance

PLUMBING

Plumbing systems assessed throughout the terminal and concourses consist of domestic hot and cold water and sanitary piping, plumbing fixtures, drinking fountains, water heating equipment and plumbing appurtenances such as reduced pressure backflow preventers.

During the visual observations of the condition of plumbing equipment, preliminary assessments were made of central water heating equipment and plumbing fixtures. Plumbing fixtures were typically assessed as a group within a restroom area. Representative samples of water supply and sanitary piping systems were observed and recorded as typical of such systems. The physical condition of piping systems cannot be established based on visual observation alone; therefore, assessment is based in part on STLAA reports of system condition.

Recommendations

- Video Inspection: Identify locations where sewer back-ups have occurred in underground piping and perform video inspection of those pipe segments. While no specific locations are identified, this effort should be undertaken throughout the facility where obstructions in underground sewer piping is suspected

FIRE PROTECTION

Fire Protection systems assessed throughout the terminal and concourses consist of automatic fire suppression sprinklers and piping, standpipes, fire protection system risers, and alternative fire suppression systems which primarily consisted of clean agent systems. Fire alarm systems were assessed as part of electrical low-voltage communication systems.

During the visual observations of the condition of fire protection systems, preliminary assessments were made of representative samples of accessible piping valves and hose cabinets. The physical condition of piping systems cannot be established based on visual observation alone; therefore, assessment is based on STLAA reports of system condition, prior non-destructive testing performed on sprinkler piping, and additional non-destructive testing performed on sprinkler piping as part of this condition assessment. Results of the most recent pipe testing indicate that interior grooving corrosion is continuing, and are included in Appendix 11G.

The airport has limited automatic fire suppression systems installed. The terminal and concourses have wet pipe sprinkler systems installed in tenant spaces and some areas that have been recently renovated, but automatic fire suppression is not installed throughout most areas of the airport facilities. Deluge systems are installed in select areas of the airport as water curtains to protect atrium windows, to isolate control areas, and to protect select outside walls from aircraft fires.

Recommendations

- **Code Review at Major Renovation**: Automatic fire suppression is not required throughout the terminal and concourses as the facility is "grandfathered" to the applicable code at the time of construction. A preliminary assessment of the airport construction and current building codes defining where automatic fire suppression is required suggests that the airport would require sprinklers throughout to comply with current codes. Based on that interpretation, any substantial renovation of airport spaces would require installation of fire sprinklers throughout the renovated area. It is also reported that the existing fire protection water supplies are not adequate to supply extensive expansion of the automatic fire sprinkler systems
- **Water Treatment**: Leakage and repairs to wet pipe sprinkler piping in 2014 led to an assessment of the sprinkler piping throughout the airport in 2015. Non-destructive piping tests performed as part of the 2015 assessment indicated grooving corrosion of the welds in electrical resistance welded (ERW) sprinkler piping. Corrosion was identified in 40 – 80% of the samples taken in Terminal 1 and Concourses A, B, C, and D, and water treatment was recommended to prolong the life of the sprinkler pipe. STLAA reports no knowledge of water treatment having been performed. In advance of large-scale replacement, add chemical corrosion inhibitor to the water in the fire protection pipe to deter the progression of corrosion
- **Pipe Replacement**: The most recent ultrasonic pipe testing indicates that the corrosion identified in 2014 is continuing, and some leaks were observed in piping where interior corrosion was detected. STLAA reports that leaks in fire protection piping are repaired as they occur. For this assessment, it is projected that all main fire sprinkler piping in Terminal 1 and concourses A-D will need to be replaced in the next 10 years. This cost is estimated as a lump sum cost at year 10. Continue replacement of fire suppression piping as pipe failures occur, and budget for a large-scale replacement of fire suppression piping at a future date to upgrade the entire piping system for improved longevity

ELECTRICAL

The Electrical assessment included an evaluation of lighting, normal power distribution, emergency power distribution and lightning protection.

In general lighting systems in the public areas of the airport are in good condition, lighting in non-public areas is in fair to poor condition. The power distribution system is generally in fair to poor condition, largely due to age. Most of the distribution equipment is original to the building construction, so except for Concourse E/Terminal 2 the equipment is between 35 and 64 years old. The emergency power distribution is generally in fair condition, the generators observed appeared to be well maintained and the runtime hours were well below life expectancy for generators. Much of the distribution equipment is older and in fair to poor condition. Lightning protection systems were only observed on the two terminal buildings and Concourse E. Neither system is compliant with NFPA 780 requirements. Much of the rooftop equipment installed after original building construction has not been connected into the system.

The overall age of the power distribution system is the biggest observation of concern. Trip characteristics of molded case breakers degrade with age and industry standard life expectancy is 30 years. Most of the circuit breaker panels throughout the airport are more than 35 years old. It was reported by Electric shop personnel that several underground medium voltage distribution feeders have failed. This issue was also cited in the 2006 Facility Assessment report.

Recommendations

- **Lighting:** Replace existing fluorescent sourced lighting with LED sourced lighting in non-public spaces. LED lighting is more efficient and lower in maintenance costs. The airport has already implemented a replacement program in the public areas of the airport
- **Power distribution:** Replace electrical equipment older than 30 years. Trip characteristics of molded case breakers degrade with age and industry standard life expectancy is 30 years for electrical equipment. With the exception of Terminal 2 and Concourse E, most of the circuit breaker panels throughout the airport are more than 35 years old

EQUIPMENT

BAGGAGE HANDLING SYSTEMS (BHS)

Baggage handling systems assessed throughout the terminal and concourses consist of all outbound (curbside) conveyor, inbound conveyor, CBIS and CBRA conveyor (TSA area) and all carousels. Assessment also includes all supporting appurtenances and electrical devices such as the motor control panels. The baggage control room is also a part of this assessment.

Recommendations

- Replace the “upper level controls system”. This would include the replacement of the operating system, user interface software, HMIs, servers, workstations, monitors and other computer peripherals
- Repair of smaller mechanical and electrical items throughout the system, especially those that pose a safety hazard to employees and passengers
- BHS system shall continue to receive the good quality maintenance it is receiving today

ROADWAYS AND BRIDGES

Roadways and Bridges are comprised of Terminal 1 arrivals drive and departures drive roadways; Terminal 1 arrivals drive and departures drive bridges; Terminal 2 arrivals drive and departures drive roadways; Terminal 2 departures drive bridge; Lambert International Boulevard (LIB) from Cypress Road at the west end to just east of the Terminal 2 intersection of Air Cargo Road and LIB at the east end; and the LIB bridge over Airflight Drive and the Terminal 1 garage entrance bridge from LIB. the LIB over Coldwater Creek bridge is not included.

Recommendations

- Reconstruction of Terminal 1 Arrivals Drive and Departures Drive roads and replacement of Terminal 1 Arrivals Drive and Departures Drive bridges, at the same time, within five years
- Complete minor rehabilitation work within a two to five-year timeframe for Terminal 2 Arrivals Drive and Departures Drive roads and Terminal 2 Departures Drive bridge
- Reconstruct Terminal 2 Arrivals Drive and Departures Drive roads and Replace Terminal 2 Departures Drive bridge, at the same time, in approximately ten to twelve years
- Reconstruct LIB and Replace LIB bridges, at the same time, within ten years

STORMWATER PUMP STATIONS

The stormwater pump station is located outside of Terminal 2 adjacent to the Terminal 2 (T2) loading dock. The purpose of the stormwater pump station is to convey stormwater under pressure to prevent flooding in the lower level of the T2 parking garage when the horseshoe storm culvert under I-70, the outer road, T2 garage, and T2 terminal becomes overcharged. The pump station is 22 years old and consists of 3 primary stormwater pumps. The capacity of the pump station is approximately 1000 L/s (15850 gpm) based on pump curves provided by the maintenance service provider for the pump station.

The assessment of the interior components of the pump station are based on information provided by Airport Subject Matter Experts and the maintenance service provider for the pump station. The noted grade piping, pump housings, vault covers and hatches, and electrical conduit were inspected on June 22, 2020.

Recommendations

- The Stormwater Pump Station does not require replacement of components at this time. The following recommendations for repairs of the stormwater pump station will extend the remaining useful life of the facility
- Sandblast and Recoat the pump housing for the three stormwater pumps and all above grade piping in the next two to five years
- Replace the dewatering pump for the stormwater pump station in the next two to five years
- Rehabilitate the station wet well, dewatering pump wet well, and valve vault by applying a structural epoxy coating in the next 10 to 15 years
- Repair the latch on the dewatering pump hatch to be operational in the next year
- Replace the pump impeller for all three (3) primary stormwater pumps in the next 10 to 15 years.
- Replace the gasket for the three stormwater pump housings in the next year

11.2.2 Terminal 1 (T1)

In 1956, Minoru Yamasaki's iconic arched terminal opened, becoming the forerunner of many modern airline terminals. Its modular dome design provided for later expansion of a fourth dome. St. Louis Lambert International Airport became one of the first U.S. airports with jet airline service when Trans World Airlines began operating the groundbreaking Boeing 707 in 1959 out of this terminal, along with airlines for American, Delta, Ozark, Eastern, Braniff, and Central Airlines. The terminal has been in service ever since its inauguration.

SUBSTRUCTURE

Terminal 1 is constructed of concrete cast-in-place reinforced concrete beams and concrete columns featuring four domed roofs at the ticketing level. Each of the domed roofs are framed with four arched concrete ribs connected with a hinge at the four corner columns. The apron level is constructed with a concrete slab-on-grade while the concourse and ticketing levels have concrete floor slabs. The structure is founded on spread footings of varying sizes and varying depths.

FOUNDATIONS

The foundations at Terminal 1 are generally not visible, however, evidence of foundation movement was not present. If the foundations had experienced movement or distress, fracturing of the concrete slabs on grade radiating from the column bases would be evident. Additionally, distress to the architectural finishes would be visible. Neither of these conditions are visibly apparent at Terminal 1. Based on available drawings, the Terminal 1 foundations are concrete piers on spread footings at various depths. The structure was constructed in the mid 1950's and is over 60 years old. The foundations are likely in fair condition given the age. This would provide a remaining useful life well past 10 years as long as regular maintenance continues to be performed, including maintaining sealant at the slab joints, maintenance of proper slopes at the perimeter of the structure, and proper storm water diversion is sustained such as gutters, downspouts, and area drains. Proper storm water management will keep excessive moisture from infiltrating the soil adjacent to the foundations causing potential foundation issues.

Recommendations

- No recommendations.

SUBGRADE ENCLOSURES AND SLABS ON GRADE

The tunnel beneath Terminal 1 and the road toward the Climate Control West building is in poor condition. During the visual assessment multiple spalled areas were observed on the slabs, the walls, and the underside of the floor above. Within these spalled areas, corroded rebar is visible, indicating moisture is infiltrating the concrete structure. Additionally, mineral deposits are visible on the floor slabs in the tunnel. In some places the entire floor surface is covered with mineral deposits. Representatives from the climate control department reported that the tunnel frequently floods after heavy rains and that the floor is slippery from the mineral deposits.

Recommendations

- Recommended repairs include the removal of spalled concrete and corroded rebar and patching in new steel reinforcement and concrete. At locations where piping will impede the recommended repair, application of a coating and/or troweled grout will suffice.
- It may be necessary to perform an additional in-depth evaluation and analysis into the cause and source of the moisture intrusion into the tunnel.

SHELL

SUPER STRUCTURE AND EXTERIOR ENCLOSURES

The concrete super structure of Terminal 1 is in fair condition. The concourse and apron levels are framed with concrete beams and columns and a concrete floor slab system. The superstructure is in fair condition where it is visible with isolated distress to a few columns. There are several locations where structural modifications were made to accommodate changes to the use of the structure. For example, the floor slab and adjacent beam was cut to accommodate the baggage handling system. Approximately three columns are noted where extensive cracking of the concrete was seen, or evidence of impact damage is noted. Multiple columns are damaged by baggage handling or other vehicles impacting the column.

The visual observation of the exterior superstructure revealed conditions ranging from fair to good condition. While there is evidence of normal deterioration of building materials and components, there is evidence of on-going maintenance, notably the window and skylight systems. These individual conditions are repaired as they arise with the on-site maintenance staff. It should be noted that the roof system on the dome is presently under renovation/replacement, creating conditions where there are temporary roof leaks during construction.

Recommendations

- Repairs to the three columns are to shore the adjacent concrete framing, remove all damaged concrete and replaced with fast setting concrete mortar. Epoxy injection may be used where there is no corrosion to the steel reinforcement after further investigation prior to the repairs. At the abraded columns, steel protective sleeve or bollards may be installed to prevent any further distress that would warrant repairs.

INTERIORS

INTERIOR CONSTRUCTION AND FINISHES

The visual observation of the interior construction and finishes of Terminal 1 revealed conditions ranging from good to very good condition. All spaces on both levels are maintained well largely due to the constant presence of passengers and airport personnel.

The apron level, below the terminal concourse, is in fair to good condition. It is strictly a utilitarian space for airport support functions, baggage claim, utility rooms, storage, etc. Therefore, a high level of finish or maintenance is not required. Minor maintenance items have been identified, however, these are items that are routinely repaired by on-staff maintenance crews.

Recommendations

- No major repairs or replacement required beyond normal maintenance.

SERVICES

CONVEYING

Terminal 1 has five hydraulic passenger elevators, one hydraulic freight elevator, seven escalators, one mechanical screw wheelchair lift, and one hydraulic passenger bag lift.

Due to aging and various replacement needs, the overall condition of the passenger elevators in Terminal 1 is poor. The passenger elevators range in age from 20 to 41 years old. Elevators T1-1 and T1-3, installed in 1979, are two of the oldest elevators in the facility. Elevator T1-6, installed in 1993, supports the Metrolink and needs a cab and door replacement. Elevator T1-4 has no apparent issues, however its installment date of 1997 suggests that it is nearing the end of its remaining useful life. Elevator T1-5, installed in 2000, needs new doors. Freight elevator T1-2 was modernized in 2011 and has no apparent issues and is in good condition.

The overall condition of the escalators in Terminal 1 is fair. Terminal 1 escalators range in age from nine to 27 years old. Escalators T1-7, T1-8, T1-11, and T1-12, installed in 1996, run 24/7. T1-8 and T1-11 each have a bull gear that makes a thumping noise while running. It is suspected that the gears were installed improperly when they were replaced in the past. Escalator T1-12 has an issue with its chain walking off the track. Escalators T1-15 and T1-16, installed in 1993, have no apparent issues, but have exceeded their life expectancy. Escalator T1-10, installed in 2011, is in good condition, however it is near an exterior window and the direct sunlight has weathered and dried out the adjacent handrail.

The overall condition of the wheelchair lift and bag lift in Terminal 1 is fair. Wheelchair lift T1-13 and bag lift T1-14, installed in 2013 and 2015 respectively, are not included in the service agreement with Midwest Elevator. Lack of comment from STLAA staff about these lifts, combined with their age means these lifts are in fair condition.

Recommendations

- Modernize elevators: T1-1 and T1-3 in fiscal year (FY) 2022; T1-6 and T1-4 in FY2022 to FY2026; T1-5 in FY2027 to FY2031; and T1-2 in FY2031 to FY2036.
- Overhaul elevators: T1-1 and T1-3 in FY2022; T1-6 and T1-4 in FY2022 to FY2026; T1-5 in FY2027 to FY2031; and T1-2 in FY2031 to FY2036.
- Overhaul escalators: T1-8, T1-11 and T1-12 in FY2022; T1-15, T1-16 and T1-7 in FY2022 to FY2026; and T1-10 in FY2027 to FY2031.
- Deep clean escalators: T1-8, T1-11, T1-12, T1-15, T1-16, T1-7, and T1-10 in FY2022.

HVAC

In Terminal 1, most central station air handling equipment is located on the apron level. These include air handlers (AHU) with steam and chilled water coils serving the concourse and ticketing level, as shown in **Figure 11.2-4**, and steam heating and ventilating units (HVU) serving the baggage handling area. Some

rooftop air handlers are also installed to condition spaces on the concourse and ticketing levels east and west of the central domes. Main air handlers are in fair condition, but some are as much as 23 years old, and are reported to be difficult to access and have failed coils.

Most air distribution in Terminal 1 is from indoor air handling equipment, but some is from rooftop units (RTU). The RTU serving the Airport Properties Department is in poor condition. Among other mechanical issues, the piping cabinet enclosure is made of plywood and sheet metal and is deteriorating. The lack of appropriate insulation and weather resistance causes the condensate line to freeze, and occasional leaks in the office area below. The RTU serving the Lindbergh Conference Room reportedly has inadequate capacity to adequately cool and dehumidify the large conference room.

Figure 11.2-4: Rooftop Air Conditioner AHU148 Serving Properties Division

Source: WSP USA, 2021.

Recommendations

- Replace RTU as they reach end of life including RTU148 serving the Properties Department. RTU 148 is in poor condition and due to the poor condition of the casing unit chilled water and condensate piping is subject to freezing. Two additional units are projected to require replacement in the next 5 years.
- The RTU serving the Lindbergh Conference Room does not provide adequate capacity to cool and dehumidify the conference room for large meetings. It is recommended that a dedicated rooftop air conditioner be installed to condition only the Lindbergh Conference Room.
- Replace and reconfigure AHU & HVU that are in poor condition on the T1 apron level. Five units are approaching the end of their useful life including HV1 through HV4. Rearranging the equipment can improve maintenance access to prolong the life of the new equipment.

PLUMBING

Plumbing systems on the apron level of Terminal 1 are generally in non-public areas. Fixtures and piping, although functional, are assessed as poor due to their age and condition. Water heating equipment and appurtenances are in fair condition. Backflow preventers owned by the airport have been inspected and tested within the past year.

Plumbing fixtures and piping on the concourse and ticketing level are in good condition, and both have been upgraded with terminal improvements.

Recommendations

- No specific plumbing recommendations apply to Terminal 1. Refer to general recommendations.

FIRE PROTECTION

Leakage and repairs to the wet pipe sprinkler piping in 2014 led to an assessment of the sprinkler piping throughout the facility in 2015. In Terminal 1, 67 percent of non-destructive piping tests performed as part of the 2015 assessment indicated interior deterioration of the sprinkler piping, and recommendations were made to prolong the life of the sprinkler pipe.

Clean agent fire suppression systems are installed in some IT and communications rooms, some of which are tenant systems. Clean agent systems using Inergen, FM200, and Novec 1230 are present. All clean agent systems are in good condition and have recently been inspected.

Recommendations

- No specific fire protection recommendations apply to Terminal 1. Refer to general recommendations.

ELECTRICAL

Lighting

Lighting is broken into two areas of evaluation, public spaces (baggage claim, security screening, and ticketing) and non-public spaces (apron level, tunnel level, STLAA departmental offices, and select spaces on the concourse level).

Generally lighting in the public spaces is in good condition. Most of the light fixtures in the public spaces of Terminal One were installed in 2013 as part of the *Airport Experience Program* . At the time of installation, the fixtures utilized fluorescent light sources for general lighting with some LED accent lighting. In the ticketing area general lighting was provided by indirect metal halide uplighting on the dome ceilings. The fluorescent light fixtures have been converted to LED light sources according to electrical shop personnel and the metal halide uplights have been replaced with LED uplights.

Lighting levels in the baggage claim area and security screening areas are adequate. Daytime light levels in the ticketing levels are adequate due to the combination of lighting system and natural daylight but night time lighting levels are less than desired and not uniform. The LED uplights do not provide enough light and are not aimed efficiently to provide uniform light levels. Lighting in these areas has a remaining useful life greater than 10 years.

Lighting in the apron and tunnel levels of the main terminal is generally in poor condition. The light fixtures are predominately fluorescent in these areas. Unfinished space generally utilizes fluorescent strip fixtures. Lighting in finished areas is a mix of recessed fluorescent and LED fixtures. Several spaces were unoccupied, and these areas tended to have obsolete fluorescent light fixtures. The occupied areas have a mix of newer LED fixtures and older fluorescent fixtures. Lighting levels were generally adequate in finished spaces. Many of the unfinished areas in baggage handling and utility spaces have lighting levels below industry standards.

Recommendations

- Recommend installing additional indirect uplighting in the ticketing area.
- Replace existing interior lighting on the apron level in a one to five-year timeframe.

Power

Main power to Terminal One is distributed at 4160v from the main west service substation to substations located on the apron level of the main terminal building which transform power down to 480/277v or 208/120v for local distribution. There are four 208/120v substations and two 480/277v substations. Many of these substations are original to the construction of the airport and more than 60 years old and are in poor condition due to their age. Most of the distribution and branch circuit panelboards in Terminal One also date to original building construction.

Emergency power is provided to Terminal One by a 1250 kw 4160v generator located in the Terminal One garage. There are four substations located on the apron level that transform emergency power down to 480/277v or 208/120v for distribution throughout Terminal One.

Recommendations

- Replace substations over 30 years old in a five to ten-year timeframe.
- Replace fusible switch distribution panels over 30 years old in a five to ten-year timeframe
- Replace branch circuit breaker panels over 30 years old in a one to five-year timeframe.

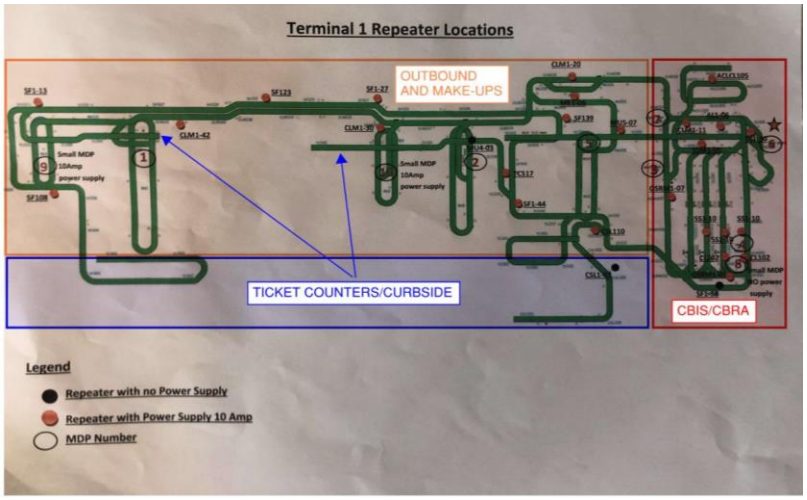
EQUIPMENT

BAGGAGE HANDLING CONVEYOR

Each Terminal conveyor is inspected from a mechanical, structural, electrical, safety and cosmetic standpoint, using visual inspections of the various subcomponents. The equipment was also observed in operation to assess how the BHS equipment was functioning and how well the system is being maintained.

The complete outbound and inbound subsystems, including the CCBIS/CBRA areas were assessed. This includes assessments of the motor control/distribution panels (MCPs). In total, about 480 conveyor sections and/or motor control/distribution panels were assessed in T1. **Figure 11.2-5** shows a snapshot from Vanderlande's (VI) Human Machine Interface (HMI) of the T1 system for reference.

Figure 11.2-5: T1 Vanderlande Baggage System HMI



Source: Cage, 2021.

Of the approximate 480 conveyors, roughly 91 percent of those are rated as “Good” (4). Only about 9 percent of the system is rated as “Fair” (3), and none of the system has an “Unsatisfactory” (1) rating. There are a few instances where conveyors behind locked doors and areas with no catwalk that are accessible; therefore, no rating is given. In addition to the 1-5 ratings, safety issues and preventative maintenance requirements were assessed. **Figure 11.2-6** provides a summary snapshot of the T1 system from the Baggage Inspection and Tracking System BITS™ software program:

Figure 11.2-6: T1 BITS™ Summary

Inspection Status

Total Equipment	Total Inspections Completed	Total Not Req'd	Percentage Complete
477	465	11	99.8%

Priority Status

Continue Normal PM's	Monitor Closely	Address Immediately
422	32	11

Work Required

PM Required	Repair	Replace
101	54	38

Equipment Scores

Not Scored	Poor - (1)	Marginal - (2)	Adequate - (3)	Good - (4)	Excellent - (5)
9	0	5	42	421	0

Noted Issues

Safety Issue Reported	Missing Parts Reported	Items Not Inspected	Tracking Issues Reported
61	29	14	54

Source: Cage, 2021.

Many of the components, both electrical and mechanical, are in good condition. Most of the system is functioning as intended and only a few issues are noted. Motors, reducers, Programmable Logic Controllers (PLCs), cables, photocells, and control stations looked in good condition for the majority of T1. There are common minor issues that were noted throughout the T1 system. Most of these are standard industry items that exist throughout other BHS systems across the country. Bearing caps, under carriage covers, ripped belt splicing, belt tears, and trim damage are some of the items noted during our assessment as shown in **Figure 11.2-7** and **Figure 11.2-8**.

Figure 11.2-7: T1 Power Turn

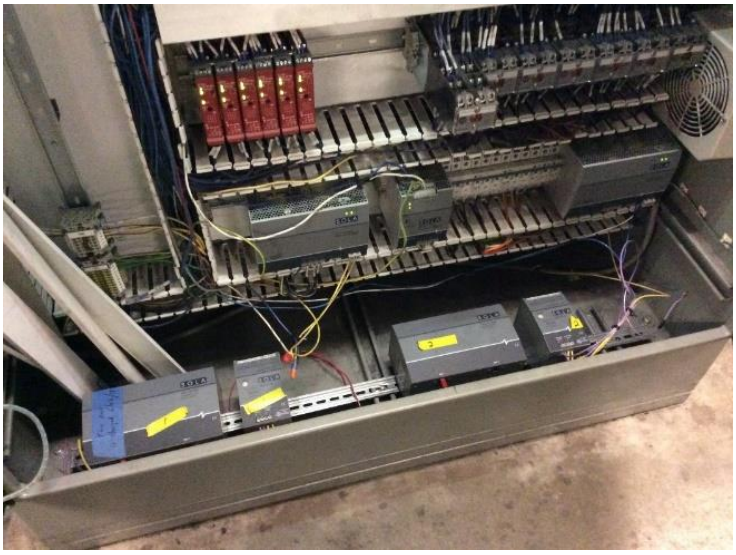
Source: Cage, 2021.

Figure 11.2-8: T1 Merge 45

Source: Cage, 2021.

Two more notable issues in T1 should be addressed immediately. A number of the MCPs have loose wires that do not appear to be terminated properly. In addition, panduit covers are laying in the bottom and have not been replaced as shown in **Figure 11.2-9**. STLAA attempted to install uninterrupted power supply (UPS) systems in the MCPs, but that effort was not completed and was left as-is. Secondly, the make-up unit, MU1, in the far west corner is a concern. The sound indicates the drive chain is slipping or catching creating a very loud jolt on the motor and reducer. In addition, there was no functioning safety alarm required by industry standard specifications. Finally, a damaged trim piece on the unit is a hazardous condition that could injure an appendage or damage loose clothing, as illustrated in **Figure 11.2-10**.

Figure 11.2-9: MDP2-T1 Panel



Source: Cage, 2021.

Figure 11.2-10: MU1-T1

Source: Cage, 2021.

Overall, the T1 BHS is in very good condition and well within industry standards. Vanderlande appears to be maintaining the system well and therefore shall extend the life of the system. In addition, the Vanderlande managers are aware of the noted safety issues. Other than the safety issues, it is recommended to continue with routine maintenance. The estimated remaining useful life of the T1 system is between 11 to 15 years.

Recommendations

- No conveyor recommendations

UPPER AND LOWER LEVEL BHS EQUIPMENT

The purpose of this assessment effort is to evaluate the condition of the equipment located in the baggage handling system (BHS) control room/s to plan for future maintenance efforts. The focus is on all upper and lower level STLAA owned equipment that are actively controlling or reporting on the BHS system within Terminal 1 and 2. The control room (CR) equipment evaluated is critical to maintaining normal BHS processing and bag operations. Equipment such as servers, workstations, monitors and computer peripherals are considered “Upper Level” equipment. Programmable Logic Controllers (PLC’s) and their peripherals are called “Lower Level” equipment. The control room facility was also surveyed for environmental, operational, and safety issues.

Most of the equipment in the Terminal 1 and 2 BHS control rooms is approximately 8 years old. These systems have been in operation since commissioning in 2012. It is estimated that the upper level system is two-thirds through its operational life. All the systems controlling and reporting on the baggage system are in the T1 and T2 control/server rooms. There are no remote data centers or other controlling locations for this BHS system.

All the host interfaces such as BSM, BPM, and FSI information are processed at these locations. The physical equipment is currently configured and maintained (VI). The servers and PLC software control functionality are maintained by Daifuku. Daifuku is subcontracted to VI to provide 24/7 (remote) support in

the event of a software, operating system, or equipment issue. Daifuku is also the original developer and installer of the current systems.

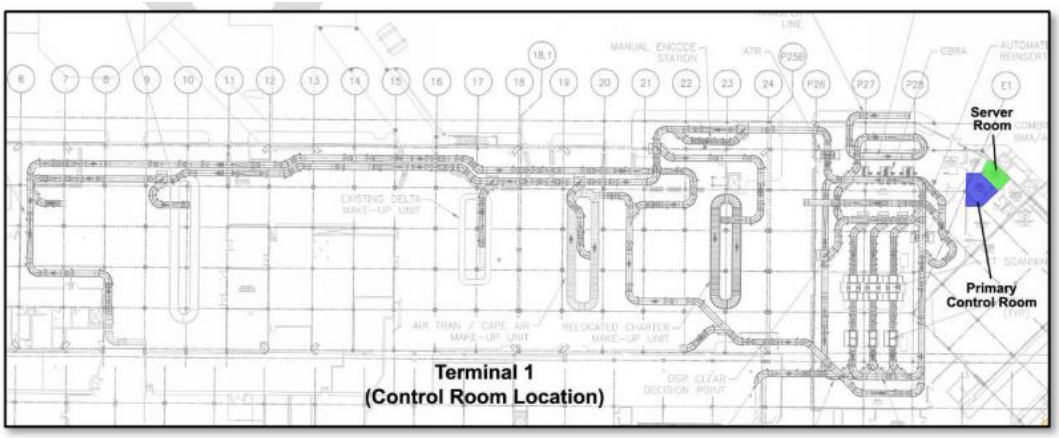
Recommendations

- No BHS equipment recommendations

T1 BHS Control Room (Primary)

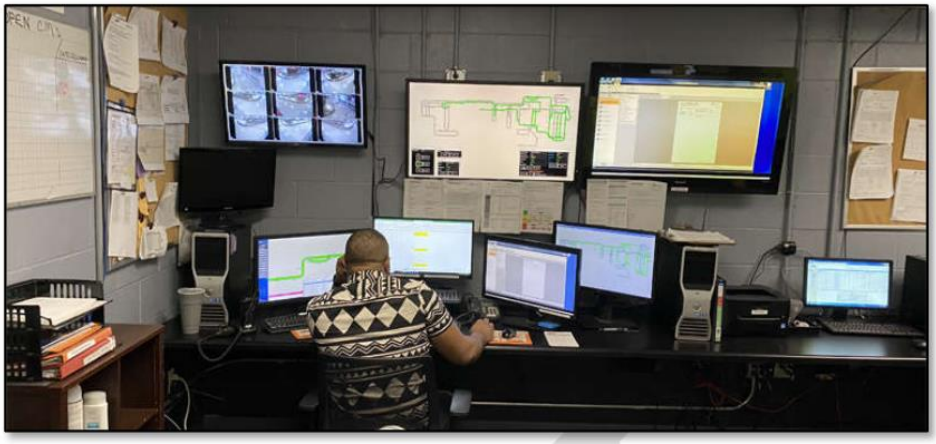
The control room at T1 is the primary control room for dispatching bag jammers and maintenance personnel for both T1 and T2. VI has installed a monitor which replicates the T2 graphics screens and reports. The T1 control room, illustrated in **Figure 11.2-11** and **Figure 11.2-12**, is relatively clean, quiet, and organized. A separate server room, with a climate-controlled temperature of 62 degrees, houses the server and PLC cabinets. This room is clean, well-lit and organized with direct access to all the equipment. The server room is also outfitted with a “dry” fire suppression system.

Figure 11.2-11: Terminal 1 Control Room Location



Source: Cage, 2021.

Figure 11.2-12: Terminal 1 Control Room



Source: Cage, 2021.

All the systems appear to be secured from unauthorized personnel and the server rooms require additional card/key access. The entire BHS network is isolated from other networks. BCS has the only VPN external access to the system to provide remote support. Universal Serial Bus’ (USB’s) on the workstations are not

locked down, allowing CR management to transfer report data to other computers for data processing. Electronic personal devices are prohibited from being used in the control room.

The system startup procedures, PLC drawings, and system as-built drawings, in hardcopy format, are present in the control room. Primary and secondary maintenance point of contacts, as well as the BCS phone number, are posted on the bulletin boards.

The workstations in the control room have client-based applications to display the BHS graphic faults and reports. Dispatchers within the control room have common edit and control functionally such as performing flight assignment table modifications and disabling automated sort diverters. The entire system can be restarted by a controlling function in the software.

All the upper level hardware and software are no longer supported and warrantied by the OEM. The Dell servers use the Server 2008 operating system (OS) and the Dell workstations use the Windows 7 OS. These operating systems no longer receive patches or updates from Dell or Microsoft. Regarding hardware, most of the components such as power supplies or hard drives or their equivalent can still be purchased online through Dell.

If the system remains isolated from other networks, the upper level systems should be maintainable for the next two or three years. When the upper level components become unavailable and an entire computer replacement is required, an image/copy of the system software will need to be tested and commissioned on the newer equipment.

The lower level hardware consisting of the PLC and network cards are still available online and a current Rockwall subscription is in place to provide troubleshooting tool sets. VI has a laptop located in the server room cabinet which has the Rockwall toolsets for opening PLC programs monitoring, making changes or updates if required. This laptop supports both T1 and T2 PLC hardware and software. It is assumed that backups of the PLC programs are stored on the laptop, if not, all the PLC programs should be backed up to a secured storage device for future use.

Overall, the controls, graphics, and reporting systems within the control rooms are performing well. The primary control room appears to be well maintained. The VI site managers reported that there have been no major outages or equipment failures in quite some time; however, power outages in the past have disrupted the systems' field devices. There are no upper or lower level issues currently impacting the operation.

Recommendations

- The current operating systems used in the upper level workstations and servers are no longer supported by the OEMs. It is estimated that the upper level control room systems have another two to three years before some of the hardware becomes obsolete or incompatible for replacement with existing equipment. It is our experience, that the process to get approval for funding, developing the specifications, and selecting a solution provider to replace the upper level can take 12 to 18 months
- Outside of commissioning in 2012, the secondary PLCs have never been brought online. It is recommended to conduct a deliberate test of the PLCs warm/hot back up switchover during non-operational hours. This will verify that the PLCs are using the same programs and that the secondary PLCs will work in the event of a Primary failover
- The latest backups of the PLC programs are presumably on the PLC support laptop and BCS is managing the programs. From an owner operator standpoint, it is recommended that the latest PLC programs be stored in a central location such as a network- attached storage (NAS) where latest revisions can be managed and properly accessed in the event of a hardware failure
- Any major BHS reconfigurations that may occur in the future may require the recontrol and/or replacement of the lower level hardware and programming systems. However, that is not recommended at this time

11.2.3 Concourse A

Concourse A is located at the west side of Terminal 1. It has terminal gates from A2 to A21. Figure 11.1-2 shows the location of Concourse A. This concourse primarily serves United, Air Canada, Delta and charters. The roof of Concourse A was hit by a tornado in 2011, and a new roof was put on six years ago. From an architectural standpoint, the overall condition of the building is good with nicely furnished hold rooms.

SUBSTRUCTURE

Concourse A is framed with steel beams and columns with lateral support provided by moment frames. The roof is supported by a steel truss system with a steel roof deck. The floor at the apron levels are concrete slabs-on-grade and the concourse floor is a composite concrete and steel floor system. The structure is founded on spread footings of varying sizes and varying depths.

FOUNDATIONS

The foundations at Concourse A are generally not visible. If the foundations had experienced movement or distress, fracturing of the concrete slabs on grade radiating from the column bases would be evident. Additionally, distress to the architectural finishes would be visible. Neither of these items are visibly apparent at Concourse A. The foundations are anticipated to be some combination of concrete piers and spread footings, and are likely in fair condition given the age. This would provide a remaining useful life well past 15 years as long as regular maintenance continues to be performed, including maintaining sealant at the slab joints, maintenance of proper slopes at the perimeter of the structure, and proper storm water diversion is sustained such as gutters, downspouts, and area drains. Proper storm water management will keep excessive moisture from infiltrating the soil adjacent to the foundations causing potential foundation issues. Currently no recommendations for repairs to the foundations is necessary.

Recommendations

- No recommendations

SUBGRADE ENCLOSURES

The tunnel beneath Concourse A is in poor condition. During the visual assessment several spalled areas were observed on the slabs, the walls, and the underside of the floor above. Within these spalled areas, corroded rebar is visible which indicates moisture is infiltrating the concrete structure. There are cracks/fractures in the floor slab periodically with some of the fractures starting to spall and chip.

Recommendations

- Removal of spalled concrete and corroded rebar and patching in new steel reinforcement and concrete
- At locations where piping will impede the recommended repair, application of a coating and/or troweled grout will suffice

SLABS ON GRADE

The slabs on grade at the exterior and at the apron level of Concourse A are in fair condition. Cracking and fracturing of the slabs are isolated. Spalling and deterioration of the surface of the slab is present in isolated locations throughout the mechanical spaces on the apron level. While these conditions do not cause any reduction in the slab's structural capacity, if left in its current state the areas of distress will accelerate and cause serviceability issues in the future.

Recommendations

- Recommended repairs include epoxy grout injection of the cracks, and the removal of spalled/deteriorated concrete and resurfacing

SHELL

SUPER STRUCTURE AND EXTERIOR ENCLOSURES

The steel super structure of Concourse A is in fair condition and no major issues with structural elements of the super structure are observed. Some of the exterior steel beam connections at the apron level exhibit corrosion. Based on the age of the structure and the current condition, the estimated remaining useful life is well beyond 10 years given proper maintenance. The steel connections should be routinely inspected by a licensed professional with special attention given to those locations that are exposed to the elements.

The visual observation of the exterior superstructure revealed conditions ranging from fair to good condition. While there are signs of normal deterioration of windows and exterior metal panel, the enclosure is in good condition. The roof system is generally in good condition and no leaking point is found inside.

Recommendations

- Recommended repairs to the steel members that exhibit corrosion include grinding away the corrosion at and painting the steel with a weather proofing paint
- A secondary drain system is recommended on roof for future renovation

INTERIORS

INTERIOR CONSTRUCTION AND FINISHES

The visual observation of the interior construction and finishes revealed conditions ranging from good to very good condition. Concourse spaces are well maintained largely due to the constant presence of passengers and airport personnel.

For the apron level, the condition is fair. It consists of several office space (ATS, Delta, etc.) as well as some utilitarian area. Most of the office spaces are aged but well maintained. Some vacant rooms need ceiling maintenance and floor cleaning. The utilitarian spaces function well, therefore a high level of finish or maintenance is not required. Minor maintenance items have been identified; these are items that are routinely repaired by on-staff maintenance crews. No further testing or maintenance required in this area.

Recommendations

- No recommendations for any major renovation or repairs beyond normal maintenance

SERVICES

CONVEYING

Concourse A has two hydraulic passenger elevators. The overall condition of the elevators in Concourse A is good. Elevators A-8 and A-17, installed in 2004, have no apparent issues.

Recommendations

- Modernize elevators: A-8 and A-17 in FY2031 to FY2036
- Overhaul elevators: A-8 and A-17 in FY2031 to FY2036

HVAC

In Concourse A, indoor central station air handling equipment is located on the apron level, and rooftop air handlers serve the concourse level. The air handlers (AHU) and rooftop units (RTU) typically have steam and chilled water coils for heating and cooling. The indoor air handlers, most of which are modular air handlers installed in approximately 2008, are in good condition as shown in **Figure 11.2-13**. Rooftop air conditioners and exhaust fans were reportedly installed in 2008 and are also in good condition.

Figure 11.2-13: Typical Newer Indoor Modular Air Handling Unit

Source: WSP USA, 2021.

Main steam, condensate return, and chilled water piping runs through the tunnels beneath the concourse. The physical condition of piping systems could not be established based on visual observation alone, and the assessment is based in part on airport reports of system condition. The main piping observed is in good condition, although some insulation is damaged or missing. Branch chilled water and steam condensate piping at connections to air handlers is commonly missing insulation. Where insulation is missing, chilled water piping is rusted, in some cases badly, due to condensation. Adjacent insulation and piping appear to be in good condition. Branch piping to rooftop units appear to be in good condition with most insulation intact.

Air distribution systems are generally observed to be in good condition. With proper humidity control in the distributed air supply, and without external physical damage, duct systems can continue in use with only periodic cleaning.

Terminal and unitary equipment on the apron level is found to be generally in poor condition. This equipment typically has a shorter expected useful life that large central equipment. Located in mostly non-public and service areas, the terminal equipment on the apron level does not receive the maintenance attention that similar equipment in public areas might receive. Some of this equipment has failed or is operating beyond its expected useful life. Convectors in mechanical rooms and fan coil units in unused service areas are either badly damaged or non-functional, as illustrated in **Figure 11.2-14**. Computer room air conditioners (CRAC) located in IT and communication rooms are typically in good condition, but there is no redundancy for cooling in these critical rooms.

Figure 11.2-14: Fan-Coil Unit Representative of Apron Level Terminal Equipment

Source: WSP USA, 2021.

Some bird screens and filters on air intake louvers and bird screens on exhaust louvers are heavily coated with dirt and debris. Some bird screens on outside walls and opening into baggage handling and similar service areas are almost completely obstructed, inhibiting airflow.

Central AHU and RTU are controlled through an electronic digital control system monitored through the Building Automation System (BAS) by Climate Control in their Computer Lab near Climate Control East. The electronic controls appear and are reported to be in good condition and operation. Digital controllers by several different manufacturers were observed suggesting potential communication incompatibility between controllers. STLAA staff confirmed the communication protocol conflict with older LonWorks and newer BACnet systems and advised that Wonderware software is being installed to integrate communications.

Recommendations

- Replace RTU as they reach the end of their useful life . Ten rooftop air conditioners on Concourse A are 12 years old and are expected to require replacement in 5 – 10 years
- Replace AHU as they reach the end of their useful life. Nine air handlers in Concourse A are 12 years old and are expected to require replacement in 10-15 years

PLUMBING

Plumbing systems on the apron level of Concourse A are generally in non-public areas. Fixtures and piping have been renovated in some tenant spaces, but not in unused areas and service areas. Fixtures and piping on the apron level are assessed as fair overall. Airport steam water heaters and pumps were replaced in 2019 and are in excellent condition. Plumbing appurtenances are in fair condition. Backflow preventers owned by the airport have been inspected and tested within the past year.

Plumbing fixtures and piping on the concourse level of Concourse A are in good condition, and both have been upgraded with terminal improvements.

STLAA advised that there is only a single water service to Concourse A, so any failure or service required on that water services interrupts the water supply to all fixtures and tenants on the concourse.

Recommendations

- Identify locations where sewer back-ups have occurred in underground piping and perform video inspection of those pipe segments. While no specific such locations were identified in Concourse A, this effort should be undertaken throughout the airport where obstructions in underground sewer piping is suspected
- Install a redundant domestic water supply to Concourse A

FIRE PROTECTION

Leakage and repairs to wet pipe sprinkler piping in 2014 led to an assessment of the sprinkler piping throughout the airport in 2015. In Concourse A, 45 percent of non-destructive piping tests performed as part of the 2015 assessment indicated interior deterioration of the sprinkler piping, and recommendations were made to prolong the life of the sprinkler pipe.

Clean agent fire suppression systems are installed in some IT and communications rooms, some of which are tenant systems. All clean agent systems are in good condition and have recently been inspected.

Recommendations

- No specific fire protection recommendations apply to Concourse A. Refer to general recommendations

ELECTRICAL

Lighting

The lighting assessment is divided into two areas of evaluation: public areas consisting of the concourse and gate waiting areas and non-public areas consisting of the apron level and spaces on the concourse level that are secured from general public access. Lighting in tenant spaces is not included in the assessment. That is, apron tenant spaces occupied by airlines were excluded whereas unoccupied and contractor occupied spaces were included in the evaluation.

Lighting in the public space is in fair condition. The concourse lighting illustrated in **Figure 11.2-15** was installed with fluorescent lamps as part of the Airport Experience project around 2013 but have been converted to LED light sources according to electrical shop personnel. The general lighting fixtures in the gate waiting areas are older 4’ x 4’ pendant mounted fixtures, originally fluorescent that have also been switched over to LED light sources. There are also some pendant mounted accent lights that are outdated, some still have incandescent par lamps. Lighting levels in Concourse A public spaces is generally adequate.

Lighting in the apron and tunnel levels of Concourse A is generally in poor shape. The light fixtures are predominately fluorescent in these areas. Unfinished space generally utilizes fluorescent strip fixtures. Some of the tenant office spaces have recessed fluorescent fixtures. Lights in finished areas are a mix of recessed fluorescent fixtures. The tunnel level of Concourse A is lit by fluorescent strip light fixtures. Emergency egress lighting on the apron level is deficient. Several areas have exit lights that are no longer working or that failed the pushbutton battery check test.

Power

Power distribution equipment on the apron level of Concourse A is generally in poor condition. Much of the equipment is still in place from the original construction 60 years ago. As a general rule, life cycle expectancy for electrical equipment is around 30 years.

Main power is distributed around the airport at 4160v to substations located throughout the airport which transform power down to 480/277v or 208/120v for local distribution. Concourse A has five 480/277v and one 208/120v substations power distribution system. Four of the substations appear to be original equipment. Two of the substations are newer and in fair condition and most of the medium voltage switches in Concourse A have been replaced and are in good condition. Most of the distribution and branch circuit panelboards also date to original building construction.

There are no substations located on the concourse level. Most of the distribution and branch circuit panelboards on the concourse level also date to original building construction and are in poor condition.

The generator providing emergency power to Concourse A is in good condition. The emergency power distribution panels are older fused switch panels in fair condition. Two of the three branch circuit panels are older circuit breaker panels in poor condition.

The observable conduit and wire distribution system is in fair condition. Generally, conduit and wire installed above ground in dry non-corrosive environments will function indefinitely if not subjected to damage or overloads.

Figure 11.2-15: Concourse A Lighting

Source: WSP USA, 2021.

Recommendations

- Replace substations over 30 years old in a five to ten-year timeframe
- Replace fusible switch distribution panels over 30 years old in a five to ten-year timeframe
- Replace branch circuit breaker panels over 30 years old in a one to five-year timeframe
- Replace existing interior lighting on the apron level
- Replace waiting area lighting on the concourse level

11.2.4 Concourse B

Concourse B is located at the north side of Terminal 1. The hold room is no longer used for aircraft operations, currently used for exhibitions, press conferences, and other events. The roof age of Concourse B is around five years. From a general architectural standpoint, Concourse B's conditions range from good to very good condition.

SUBSTRUCTURE

Concourse B is constructed like Concourse A, framed with steel beams and columns with lateral support provided by moment frames. The roof is supported by a steel truss system with a steel roof deck. The floor at the apron levels are concrete slabs-on-grade and the concourse floor is a composite concrete and steel floor system. The structure is founded on spread footings of varying sizes and varying depths.

FOUNDATIONS

The foundations at Concourse B are generally not visible. Evidence of foundation movement is not present. If the foundations had experienced movement or distress, fracturing of the concrete slabs on grade radiating from the column bases would be evident. Additionally, distress to the architectural finishes would be visible. Neither of these items are visibly apparent at Concourse B. The foundations are anticipated to be some combination of concrete piers and spread footings and are likely in fair condition given the age. This would provide a remaining useful life well past 15 years as long as regular maintenance continues to be performed including maintaining sealant at the slab joints, maintenance of proper slopes at the perimeter of the structure, and proper storm water diversion sustained such as gutters, downspouts, and area drains. Proper storm water management will keep excessive moisture from infiltrating the soil adjacent to the foundations causing potential foundation issues.

Recommendations

- No recommendations for repairs to the foundations necessary

SUBGRADE ENCLOSURES

The tunnel beneath Concourse B is in poor condition. Several spalled areas are visible on the slabs, the walls, and the underside of the floor above. Within these spalled areas, corroded rebar is visible which indicates moisture is infiltrating the concrete structure. There are cracks/fractures in the floor slab periodically with some of the fractures starting to spall and chip. In one of the mechanical spaces which is recessed from the tunnel, three column footings are deteriorating and spalling.

Recommendations

- Removal of spalled concrete and corroded rebar and patching in new steel reinforcement and concrete. At locations where piping will impede the recommended repair, application of a coating and/or troweled grout will suffice

SLABS ON GRADE

The slabs on grade at the exterior and at the apron level of Concourse B are in fair condition. Cracking and fracturing of the slabs are isolated. Spalling and deterioration of the surface of the slab is present in isolated locations throughout the mechanical spaces on the apron level. While these conditions do not cause any reduction in the slab's structural capacity, if left in its current state the areas of distress will accelerate and cause serviceability issues in the future.

Recommendations

- Epoxy grout injection of the cracks, and the removal of spalled/deteriorated concrete and resurfacing

SHELL

SUPER STRUCTURE AND EXTERIOR ENCLOSURES

The steel super structure of Concourse B is in fair condition. The structure is comprised of steel beams and columns with a composite steel and concrete floor deck. The roof is supported by steel trusses and a steel deck. No major issues with structural elements of the super structure are observed. Some of the exterior steel beam connections at the apron level exhibit corrosion. Based on the age of the structure and the current condition the estimated remaining useful life is well beyond 15 years with proper maintenance. The steel connections should be routinely inspected by a licensed professional with special attention given to those locations that are exposed to the elements.

The visual observation of the exterior superstructure revealed conditions ranging from fair to good condition. While there is sign of normal deterioration of windows and walls, the enclosure is in good condition and only require some cleaning work. There is damage on the north façade from a car impact. Minor maintenance items have been identified; these are items that are routinely repaired by on-staff maintenance crews.

The roof system is generally in good condition yet there are some leaking points on the Concourse B extension while leaving some stain marks, which may require further investigation.

Recommendations

- Recommended repairs are isolated to grinding away and corrosion at the steel connections and painting the steel with a weather proofing paint
- A secondary drain system is recommended on roof for future renovation
- To further investigate the leaking on B extension, a roof core test is recommended to examine the extent of water transmission into the roof system

INTERIORS

INTERIOR CONSTRUCTION AND FINISHES

The visual observation of the interior construction and finishes revealed conditions ranging from fair to good condition. Spaces in Concourse B are well maintained. However, in the Concourse B extension, leaks have caused stain on both the ceiling and carpet as well as some rust on the steel structures above. Other spaces are well maintained.

As for the apron level, the condition is fair. Most spaces are utilitarian supporting the concourse level including mechanical, electric rooms, etc. While functional, these spaces are old and are in need of repair on the cracks on walls and floors. For the office spaces, there are some water stains on the ceiling which might be caused by a potential plumbing leaking. Those should be repaired by onsite crew. No further testing and minor repairing are required in this area.

Recommendations

- Besides the ongoing maintenance, it is recommended that the vacant areas be demolished to a "white box" condition to prepare for a future use."

SERVICES

CONVEYING

Concourse B has two hydraulic passenger elevators. The overall condition of the elevators in Concourse B is poor. Elevator B-14, installed in 1996, is nearing the end of its useful life and needs cab and door improvements. Elevator B-4, installed in 2002, is not currently operating due to water damage.

Recommendations

- Modernize elevators: B-14 in FY2022 to FY2026; and B-4 in FY2027 to FY2031
- Overhaul elevators: B-4 in FY2022; and B-14 in FY2022 to FY2026

HVAC

In Concourse B, indoor central station air handling equipment is located on the apron level, and rooftop air handlers serve the concourse level which is used for large training rooms and open event space. The air handlers (AHU) and rooftop units (RTU) typically have steam and chilled water coils for heating and cooling. The indoor air handlers, most of which are modular air handlers installed in approximately 2008, are in good condition. Rooftop air conditioners and exhaust fans were reportedly installed in 2008 and are also in good condition.

Main steam, condensate return, and chilled water piping run through the tunnels beneath the concourse. The physical condition of piping systems cannot be established based on visual observation alone, and assessment is based in part on airport reports of system condition. This main piping is and is reported to be in good condition, although some insulation is damaged or missing. Branch chilled water and steam

condensate piping at connections to air handlers is commonly missing insulation. Where insulation is missing, chilled water piping is rusted, in some cases badly, due to condensation. Adjacent insulation and piping appear to be in good condition. Branch piping to rooftop units appear to be in good condition with most insulation intact.

Air distribution systems are generally in good condition. With proper humidity control in the distributed air supply, and without external physical damage, duct systems can continue in use with only periodic cleaning.

Terminal and unitary equipment on the apron level are generally in poor condition. This equipment typically has a shorter expected useful life than large central equipment. Located in mostly non-public and service areas, the terminal equipment on the apron level does not receive the maintenance attention that similar equipment in public areas might receive. Some of this equipment has failed or is operating beyond its expected useful life. Convectors in mechanical rooms and fan coil units in unused service areas are either badly damaged or non-functional. Computer room air conditioners (CRAC) located in IT and communication rooms are typically in good condition, but there is no redundancy for cooling in these critical rooms.

Some bird screens and filters on air intake louvers and bird screens on exhaust louvers are heavily coated with dirt and debris. Some bird screens on outside walls and opening into baggage handling and similar service areas are almost completely obstructed, inhibiting airflow.

Central AHU and RTU are controlled through an electronic digital control system monitored through the Building Automation System (BAS) by Climate Control in their Computer Lab near Climate Control East. The electronic controls appear and are reported to be in good condition and operating well. Digital controllers by several different manufacturers suggest potential communication incompatibility between controllers. STLAA staff confirmed the communication protocol conflict with older LonWorks and newer BACnet systems and advised that Wonderware software is being installed to integrate communications.

Recommendations

- Replace RTU as they reach the end of their useful life. Five rooftop air conditioners on Concourse B are 12 years old and are expected to require replacement in 5 – 10 years. One unit is 24 years old and is expected to require replacement within 5 years

PLUMBING

In Concourse B, plumbing systems on the apron level are generally in non-public areas. Fixtures and piping on the apron level are in poor condition with some fixtures non-functional.

Plumbing fixtures and piping on the concourse level are in fair condition but some leaks in plumbing chases are observed. Plumbing in Concourse B was not upgraded at the same time as plumbing improvements in Concourses A, and C as part of the terminal improvements.

Airport steam water heaters and pumps were replaced in 2019 and are in excellent condition. Plumbing appurtenances are in fair condition. Backflow preventers owned by the STLAA were inspected and tested within the past year.

Recommendations

- Identify locations where sewer back-ups have occurred in underground piping and perform video inspection of those pipe segments. While no specific locations were identified in Concourse B, this effort should be undertaken throughout the facility where obstructions in underground sewer piping is suspected

FIRE PROTECTION

Leakage and repairs to wet pipe sprinkler piping in 2014 led to an assessment of the sprinkler piping throughout the airport in 2015. In Concourse B, 44 percent of non-destructive piping tests performed as part of the 2015 assessment indicated interior deterioration of the sprinkler piping, and recommendations were made to prolong the life of the sprinkler pipe.

Clean agent fire suppression systems are installed in some IT and communications rooms, some of which are tenant system. All clean agent systems are in good condition and have recently been inspected.

Recommendations

- No specific fire protection recommendations apply to Concourse B. Refer to general recommendations

ELECTRICAL

Lighting

The lighting in the apron level of Concourse B is generally in poor shape. The light fixtures are predominately fluorescent in these areas. Unfinished space generally utilizes fluorescent strip fixtures. Lights in finished areas are a mix of recessed fluorescent fixtures. Emergency egress lighting on the apron level is deficient. Several areas have exit lights that are no longer working or that failed the push-button battery check test. The tunnel level of Concourse B is lit by fluorescent strip light fixtures. Light levels in the tunnel are low and uneven.

The concourse level lighting was not replaced in the 2013 renovation project. The main corridor has older linear pendant mounted fluorescent fixtures and some newer recessed volumetric 2’ x 2’ fixtures in grid ceiling. The general lighting fixtures in what were gate waiting areas are older 4’ x 4’ pendant mounted fixtures, originally fluorescent that have also been switched over to LED light sources. The main corridor down the concourse has linear pendant mounted fluorescent fixtures. The north end of the concourse has been converted into a large meeting area and is lit by a combination of newer recessed volumetric 2’ x 2’ fixtures in grid ceiling and older 4’ x 4’ pendant mounted fixtures.

Power

Power distribution equipment on the apron level of Concourse B is generally in poor condition. Much of the equipment is still in place from the original construction 60 years ago. As a general rule, life cycle expectancy for electrical equipment is around 30 years.

Main power is distributed around the airport at 4160v to substations located throughout the airport which transform power down to 480/277v or 208/120v for local distribution. Concourse B has five 480/277v and one 208/120v substation, all fed from the Main West substation. One of the substations appears to be original equipment. One of the substations is newer and in fair condition. Most of the distribution and branch circuit panelboards also date to original building construction. The tunnel in Concourse B has several metal conduits that show corrosion.

There are no substations located on the concourse level. Most of the distribution and branch circuit panelboards on the concourse level also date to original building construction and are in poor condition.

There are two generators providing power to Concourse B. Generator #60 provides emergency power to the Operations Center located at the end of Concourse B. This generator is in good condition. Generator #50 provides emergency power to the rest of Concourse B and is in poor condition.

Recommendations

- Replace substations over 30 years old in a five to ten-year timeframe
- Replace fusible switch distribution panels over 30 years old in a in a five to ten-year timeframe
- Replace branch circuit breaker panels over 30 years old in a in a one to five-year timeframe
- Replace emergency generator #50 (CIP in progress)
- Replace existing interior lighting on the apron level
- Replace general lighting on the concourse level except the area with recessed volumetric 2’ x 2’ fixtures in grid ceiling

11.2.5 Concourse C

Concourse C is located at the northeast side of Terminal 1. This is a large concourse building with roughly 1,600 ft distance from one end to another. Concourse C has two sections, the original concourse and the extension which was added in 1982. Part of Concourse C is operating while the C Extension (gates east of C24) was vacated in 2003. However, starting in 2016, the Airport initiated a program to renovate holdrooms and install passenger boarding bridges. Since then, four gate rooms have been brought back on-line. A new roof was constructed after a tornado damaged the "knuckle" in 2011; then the extension roof was replaced a few years later. From a general architectural standpoint, Concourse C's conditions range from good to very good for the operational part and poor to fair for the vacant part.

SUBSTRUCTURE

Concourse C is also constructed like Concourses A and B, framed with steel beams and columns with lateral support provided by moment frames and a steel truss system supporting the steel roof deck. The floor at the apron level is also concrete slab-on-grade and the concourse floor is a composite concrete and steel floor system. Like the other concourses, the structure spread footings vary in size and depth.

FOUNDATIONS

The foundations at Concourse C are generally not visible. Evidence of foundation movement is not present. If the foundations had experienced movement or distress, fracturing of the concrete slabs on grade radiating from the column bases would be evident. Additionally, distress to the architectural finishes would be visible. Neither of these items are visibly apparent at Concourse C. The foundations are anticipated to be some combination of concrete piers and spread footings and are likely in fair condition given the age. This would provide a remaining useful life well past 15 years as long as regular maintenance continues to be performed including maintaining sealant at the slab joints, maintenance of proper slopes at the perimeter of the structure, and proper storm water diversion sustained such as gutters, downspouts, and area drains. Proper storm water management will keep excessive moisture from infiltrating the soil adjacent to the foundations causing potential foundation issues.

Recommendations

- No recommendations for repairs to the foundations necessary

SUBGRADE ENCLOSURES

The tunnel beneath Concourse C is in poor condition. During the visual assessment several spalled areas were observed on the slabs, the walls, and the underside of the floor above. Within these spalled areas, corroded rebar is visible which indicates moisture is infiltrating the concrete structure. Representatives from the climate control department reported that the sewer frequently backs up and floods the tunnel. Standing waters was present in multiple locations during the site visit.

Recommendations

- Removal of spalled concrete and corroded rebar and patching in new steel reinforcement and concrete. At locations where piping will impede the recommended repair, application of a coating and/or troweled grout will suffice

SLABS ON GRADE

The slabs on grade at the exterior and at the apron level of Concourse C is in poor condition. Cracking and fracturing of the slabs are widespread. Spalling and deterioration of the surface of the slab is present in isolated locations throughout the mechanical spaces on the apron level. While these conditions do not cause any reduction in the slab's structural capacity, if left in its current state the areas of distress will accelerate and cause serviceability issues in the future.

Recommendations

- Epoxy grout injection of the cracks, and the removal of spalled/deteriorated concrete and resurfacing

SHELL

SUPER STRUCTURE AND EXTERIOR ENCLOSURES

The steel super structure of Concourse C is in fair condition. The structure is comprised of steel beams and columns with a composite steel and concrete floor deck. The roof is supported by steel trusses and a steel deck. During the visual assessment site visits, no major issues with structural elements of the super structure were observed. In the eastern most portion of the Concourse C extension, there appeared to be a roof leak that was causing some corrosion to a truss connection. Based on the age of the structure and the current condition the estimated remaining useful life is well beyond 15 years given proper maintenance. The steel connections should be routinely inspected by a licensed professional with special attention given to those locations that are exposed to the elements.

The visual observation of the exterior superstructure revealed conditions ranging from fair to good condition. While there is sign of normal deterioration of windows and walls, the enclosure is in good shape and might only require some cleaning work. The roof system is generally in good condition, but there is a leak in the roof system near the skylight in the C extension. The skylight may have failed due to age, a key indicator being the glass panels have turned yellow.

Recommendations

- Recommended repairs are isolated to grinding away and corrosion at the steel connections and painting the steel with a weather proofing paint
- A secondary drain system is recommended on the roof for future renovation
- To further investigate the leaking on C extension, especially on and around the skylight, a roof core test is recommended to examine the extent of water transmission into the roof system

INTERIORS

INTERIOR CONSTRUCTION AND FINISHES

The visual observation of the interior construction and finishes revealed conditions ranging from poor to good condition depending on if the space is occupied. Spaces of Concourse C are maintained well up to approximately Gate 24, while the C extension (east of gate 24) is in poor condition due to water leaking, there are stains on the carpet and the corridor ceiling is falling. It is recommended to first assess and repair the roof lead and then assess the condition of floor for repair or replacement. Spaces other than those leaking spots are well maintained.

For the apron level, the condition is fair. Most spaces are utilitarian supporting the concourse level including mechanical, electric rooms, and others. While functional, these spaces are old and in need of repair on the cracks on walls and floors. The apron level at the C extension was the previous customs area for international flights. These areas have been long vacated, therefore some leaking plumbing fixtures are causing stains on the carpet and collapsing the ceiling tile. In addition, some rolling doors are deformed needing replacement. Otherwise, no major damage is apparent in this area. Depending on the STLAA needs, further testing or maintenance will take place at C extension apron level. No further testing is needed at apron level.

Recommendations

- Demolish areas in disrepair into a “white box” condition for preparation of future use

SERVICES

CONVEYING

Concourse C has three hydraulic passenger elevators. Concourse C Extension has one hydraulic passenger elevator, six moving walkways, and one hydraulic passenger man lift.

The overall condition of the passenger elevators in Concourse C is poor. Elevator C-12, installed in 1977, is currently not in service and has exceeded its life expectancy. Elevator C-18, installed in 1983, needs cab and door improvements. Elevator C-7, installed in 2010, is exposed to the outdoors, but is in fair condition.

The overall condition of the passenger elevator in Concourse C Extension, C-28, is poor. C-28 was installed in 1983, modernized in 2005, and needs cab and door improvements. The passenger man lift in Concourse C Extension, C-30, is out of service and assumed to be in fair condition.

The overall condition of the moving walkways in Concourse C Extension is poor. Moving walkways C-1 through C-6 are out of service and are not a part of the service agreement with Midwest Elevator. The walkways are possibly deteriorating from lack of use and maintenance.

Recommendations

- Modernize elevators: C-12, C-18 and C-28 in FY2022. Since C-12 is currently out of service, modernization can be done at such time as the building is back in service
- Overhaul elevators: C-12, C-18 and C-28 in FY2022. Since C-12 is currently out of service, overhaul can be done at such time as the building is back in service
- Overhaul moving walkways: C-1, C-2, C-3, C-4, C-5, C-6 in FY2027 to FY2031. Since C-1 through C-6 are currently out of service, overhaul can be done at such time as the building is back in service
- Deep clean moving walkways: C-1, C-2, C-3, C-4, C-5, C-6 in FY2022. Since C-1 through C-6 are currently out of service, deep cleaning can be done at such time as the building is back in service

HVAC

Concourse C was damaged by the 2011 tornado and much of the HVAC system was repaired or replaced in the subsequent renovation. The Concourse C Extension was constructed in 1982 after Concourse C, but the C Extension was not renovated with Concourse C and has been out of service for many years. Much of the equipment on the C Extension dates back to the original construction in 1982.

In Concourse C, indoor central station air handling equipment is located on the apron level, and rooftop air handlers serve the concourse level. The air handlers (AHU) and rooftop units (RTU) typically have steam and chilled water coils for heating and cooling. The indoor air handlers, most of which are modular air handlers installed in approximately 2008, are in good condition. Rooftop air conditioners and exhaust fans were reportedly installed in 2008, or were replaced in 2011, and most are also in good condition.

In the C Extension, indoor central station air handling equipment located on the apron level, and rooftop air handlers typically have steam and chilled water coils for heating and cooling. The indoor air handlers, and the rooftop air conditioners appear to be the original equipment installed in 1982. Rooftop equipment all appear to be in poor condition, and some may not be functional.

Main steam, condensate return, and chilled water piping run through the tunnels beneath the concourse. The physical condition of piping systems cannot be established based on visual observation, therefore assessment is additionally based on airport reports of system condition. The reports state that the main piping is in good condition, although some insulation is damaged or missing. Branch chilled water and steam condensate piping at connections to air handlers is commonly missing insulation. Where insulation is missing, chilled water piping is rusted, in some cases badly, due to condensation. Branch piping to rooftop units on Concourse C and the C Extension appear to be in good condition with most insulation intact.

Air distribution systems in Concourse C and the C Extension are in good condition. Some ductwork in the unfinished east end of the C Extension has been removed or is damaged. With proper humidity control in the distributed air supply, and without external physical damage, duct systems can continue in use with only periodic cleaning.

Terminal and unitary equipment on the apron level is generally in poor condition. This equipment typically has a shorter expected useful life than large central equipment. Located in mostly non-public and service areas, the terminal equipment on the apron level does not receive the maintenance attention that similar

equipment in public areas might receive. Some of this equipment has failed or is operating beyond its expected useful life. Convectors in mechanical rooms and fan coil units in unused service areas are either badly damaged or non-functional. Computer room air conditioners (CRAC) located in IT and communication rooms are typically in good condition, but there is no redundancy for cooling in these critical rooms.

Some bird screens and filters on air intake louvers and bird screens on exhaust louvers for air handling equipment of the old C concourse are heavily coated with dirt and debris. Some bird screens on outside walls and opening into baggage handling and similar service areas on the apron level are almost completely obstructed from lack of maintenance, inhibiting airflow.

Central AHU and RTU are controlled through an electronic digital control system monitored through the Building Automation System (BAS) by Climate Control in their Computer Lab near Climate Control East. Some older pneumatic control systems are observed that appear to be monitored by the electronic controls. The electronic controls appear and are reported to be in good condition and operating well. Digital controllers by several different manufacturers are observed, suggesting potential communication incompatibility between controllers. STLAA staff confirmed the communication protocol conflict with older LonWorks and newer BACnet systems, and advised that Wonderware software is being installed to integrate communications.

Recommendations

- Upgrade control systems to eliminate obsolete pneumatic controls and upgrade electronic controls to a uniform communication protocol
- Replace AHU as they reach the end of their useful life including AHU on the apron level of the C Concourse Extension that have failed or are in poor condition. Nine air handlers in Concourse C are 12 years old and are expected to require replacement in 10-15 years. Six air handlers in the Concourse C Extension are 38 years old and have exceeded their useful life expectancy. Two air handlers in the Concourse C Extension are 12 years old and are expected to require replacement in 10 – 15 years. AHU in the Concourse C Extension should be replaced as required for maintenance conditioning of the unused concourse, or at such time as the concourse is reopened
- Replace RTU as they reach the end of their useful life, including all RTU on the C Concourse Extension. Eight rooftop air conditioners on Concourse C are 12 years old and are expected to require replacement in 5 – 10 years. All of the rooftop air conditioners on Concourse C Extension are 38 years old and have exceeded their useful life expectancy. RTU on Concourse C Extension should be replaced as required for maintenance conditioning of the unused concourse, or at such time as the concourse is reopened

PLUMBING

In Concourse C, plumbing systems on the apron level, illustrated in **Figure 11.2-16**, are generally in non-public areas. Fixtures and piping on the apron levels of both Concourse C and the C Extension are assessed as poor overall but included some areas in unused tenant areas where plumbing had failed and is considered unsatisfactory.

Plumbing fixtures and piping on the concourse level of Concourse C were upgraded in 2011 and are in good condition. Fixtures in the C Extension are in fair condition. Some restroom groups at the west end of

the C Extension had been renovated but piping and fixtures in the remainder of the C Extension had not been improved.

Airport steam water heaters and pumps were replaced in 2019 and are in excellent condition. Plumbing appurtenances are in fair condition. Backflow preventers owned by the airport were inspected and tested within the past year.

Figure 11.2-16: Concourse C - Apron Level Plumbing Fixtures

Source: WSP USA, 2021.

Recommendations

- Identify locations where sewer back-ups have occurred in underground piping and perform video inspection of those pipe segments. There is evidence of prior sewer back-ups in the tunnels below Concourse C, but this effort should be undertaken throughout the airport where obstructions in underground sewer piping is suspected
- Replace plumbing fixtures and piping in any occupied areas on the apron level of Concourse C and the C Extension. Remove fixtures and piping in unused areas on the apron level of Concourse C and the C Extension. Stagnant water in domestic water supplies can grow bacteria which can then spread to portions of domestic water systems in use
- Upgrade piping to restroom groups in use on the concourse level of Concourses C and the C Extension. Shut off and drain piping to unused toilet groups in the C Extension. Stagnant water in domestic water supplies can grow bacteria which can then spread to portions of domestic water systems in use
- Upgrade piping and fixtures in restroom groups to be put into service on the concourse level of the Concourse C Extension
- Upgrade piping and fixtures in restroom groups in Concourse C as fixtures reach the end of their service life. Average plumbing fixture useful life is estimated to be 30 years with plumbing trim requiring replacement every 10 years

FIRE PROTECTION

Leakage and repairs to wet pipe sprinkler piping in 2014 led to an assessment of the sprinkler piping throughout the airport in 2015. In Concourse C, and C Extension 60% and 40% of non-destructive piping tests performed as part of the 2015 assessment indicated interior deterioration of the sprinkler piping respectively, and recommendations were made to prolong the life of the sprinkler pipe.

Clean agent fire suppression systems are installed in some IT and communications rooms, some of which are tenant systems. All clean agent systems are in good condition and have recently been inspected.

Recommendations

- No specific fire protection recommendations apply to Concourse C. Refer to general recommendations

ELECTRICAL

Lighting

In the original section of the concourse, lighting in the public space is in fair condition. The concourse lights were installed with fluorescent lamps as part of the Airport Experience project around 2013 but have been converted to LED light sources according to electrical shop personnel. The general lighting fixtures in the gate waiting areas are older 4' x 4' pendant mounted fixtures, originally fluorescent that have also been switched over to LED light sources. Lighting levels in Concourse C public spaces are generally adequate.

Lighting in the C Extension was not renovated during the 2013 Airport Experience project. The end of the concourse has a higher ceiling with HID high bay fixtures with a prismatic lens. The skylights near the end of the concourse also have HID light fixtures. These are either wall or pendent mounted cylinders. Some of the HID lamps have been replaced with LED replacement lamps.

Lighting in the apron and tunnel levels of the Concourse C is generally in poor shape. However, between 2015 and 2019, lighting in the holdrooms at Gate C27, C28, C29 and C30 and the public spaces that serve those gates was renovated to LED. The light fixtures are predominately fluorescent in these areas. Unfinished space generally utilizes fluorescent strip fixtures. Lights in finished areas are a mix of recessed fluorescent fixtures. Emergency egress lighting on the apron level is deficient. Several areas had exit lights that are no longer working or that failed the pushbutton battery check test. The tunnel level of Concourse C is lit by fluorescent strip light fixtures.

Power

Power is distributed to Concourse C at 4160v from the Main East substation. Eight substations located throughout Concourse C transform power down to 480/277v or 208/120v for local distribution. Concourse C has four 480/277v and four 208/120v substations. Most of the substations appear to be original equipment. One of the substations is newer and in fair condition. Most of the distribution and branch circuit panelboards also date to original building construction.

There are no substations located on the concourse level. Most of the distribution and branch circuit panelboards on the concourse level also date to original building construction and are in poor condition.

There are three generators providing emergency power to Concourse C. Two generators provide power to the original section of C concourse. These generators are in good shape. The generator providing power to the C extension is more than 40 years old and in poor shape.

Recommendations

- Replace substations over 30 years old in a five to ten-year timeframe
- Replace fusible switch distribution panels over 30 years old in a five to ten-year timeframe
- Replace branch circuit breaker panels over 30 years old in a one to five-year timeframe
- Replace emergency generator #80 (CIP in progress)
- Replace existing interior and egress lighting on the apron level
- Replace general lighting on the concourse extension section

11.2.6 Concourse D

Concourse D is located at the southeast side of Terminal 1. It continues east and connects with Concourse E. The light rail structure has columns that penetrate through the roof of Concourse D to footings below the apron level. Concourse D was vacated in 2003. Gates D8 and D10 were reopened for commuter airlines around year 2007 and all gates were reopened following the 2011 tornado and remained in use until 2012. Thereafter all D gates were vacated. However, the enclosed rooms closest to Terminal 1 have remained in use for office and storage. The concourse level hasn't been put into use for years but seems well maintained. From a general architectural standpoint, Concourse D's conditions range from good to very good condition.

SUBSTRUCTURE

Like concourses A, B, and C, Concourse D is a steel framed structure with moment frames. The apron level differs from the other concourses in that various mechanical rooms are submerged below grade. There are shallow bearing foundation walls between the columns that support the exterior concrete masonry unit walls.

FOUNDATIONS

The foundations at Concourse D are generally not visible. The foundations are anticipated to be some combination of concrete piers and spread footings. The mechanical rooms at the apron level are below grade and there are concrete stem walls supporting the exterior concrete masonry unit (CMU) walls. At one location in mechanical room D1126, the stem wall exhibits extensive fractures between the adjacent columns and is leaning inward. There is a separation between the stem wall and the CMU wall which further indicates the inward deflection of the wall. Additionally, concern was reported during the interviews with the Building Maintenance department that the further movement is occurring of the Concourse D structure.

Further investigation into the extent of the movement at Concourse D was performed during early September 2020. The results of the supplemental investigation indicate that visible cracking and inward leaning on the below grade stem walls is isolated to three mechanical room locations. The investigation further revealed no apparent issues with the building's columns of footings. The report from the supplemental inspection is included in Appendix 11F.

Recommendations

- No recommendations

SUBGRADE ENCLOSURES

The tunnel beneath Concourse D is in good condition. Unlike the tunnel at concourses A, B, and C, the D tunnel is predominately at the apron level and is recessed at the locations of the mechanical rooms. Cracks and fractures are present on the slab every 20-30 feet. No other distress is found in the concrete tunnel. No recommendations for repairs to the concrete tunnel is necessary.

Recommendations

- No recommendations

SLABS ON GRADE

The slabs on grade at the exterior and at the apron level of Concourse D are in poor condition. Cracking and fracturing of the slabs are widespread. Spalling and deterioration of the surface of the slab is present in isolated locations throughout the mechanical spaces on the apron level. While these conditions do not cause any reduction in the slab's structural capacity, if left in its current state the areas of distress will accelerate and cause serviceability issues in the future.

Recommendations

- Epoxy grout injection of the cracks, and the removal of spalled/deteriorated concrete and resurfacing

SHELL

SUPER STRUCTURE AND EXTERIOR ENCLOSURES

The steel super structure of Concourse D is in fair condition. The structure is comprised of steel beams and columns with a composite steel and concrete floor deck. The roof is supported by steel trusses and a steel deck. No major issues with structural elements of the super structure are observed. It was noted that some of the exterior steel beam connections at the apron level exhibited corrosion. Based on the age of the structure and the current condition the estimated remaining useful life is well beyond 15 years given proper maintenance. The steel connections should be routinely inspected by a licensed professional with special attention given to those locations that are exposed to the elements.

Visual observation of the exterior superstructure revealed condition is fair. While there is normal deterioration of windows and walls, the enclosure is in good shape and might only require some normal maintenance and cleaning. The majority of the roof membrane is in good condition yet just west of the connecting point of Terminal 1 and the MetroLink station, there is a severe ponding condition that should be addressed immediately.

The roof walk pad system presently installed consists of porous cementitious pads held together with a perimeter metal channel. This channel is creating a dam condition causing large areas of ponding water. Not only will this cause eventual leaking and deterioration, but it may negate any roof warranty.

Other miscellaneous issues in this area include the following:

- The rubber roof around a ventilation pipe is bent and has the potential to cause some leaking issues.
- The skylight for D has some broken film that is recommended to be replaced.

Recommendations

- Recommended repairs are isolated to grinding away corrosion at the steel connections and painting the steel with a weather proofing paint
- Performance of a roof core test as well as skylight testing are recommended

INTERIORS

INTERIOR CONSTRUCTION AND FINISHES

The visual observation of the interior construction and finishes revealed conditions ranging from fair to good condition. Although the Concourse level hasn't been operating, it is well maintained. There are only a couple of leaking points that can observed from the inside. No further maintenance needed for this area.

For the apron level, the condition is fair with most spaces being utilitarian supporting the concourse level including mechanical, electric rooms, etc. These spaces are old and need minor repairs for the cracks on walls and floors but are well functioned, so a high level of finish or maintenance may not be required except for some minor fixes. It should be noted that room D1126M has a leaning foundation wall which causes cracking at columns. Therefore, a further investigation for the structure should take place. Aside these, no urgent damage was found in this area.

Recommendations

- No recommendations

SERVICES

CONVEYING

Concourse D has one hydraulic passenger elevator, and ten moving walkways. The overall condition of the passenger elevator in Concourse D, D-13, is poor. D-13, installed in 1984, is not a part of the service agreement with Midwest Elevator and has exceeded its life expectancy.

The overall condition of the moving walkways in Concourse D is poor. Moving walkways D-1 through D-10 are out of service and are not a part of the service agreement with Midwest Elevator. The walkways are possibly deteriorating from lack of use and maintenance.

Recommendations

- Modernize elevator D-13 in FY2022
- Overhaul elevator D-13 in FY2022
- Overhaul moving walkways: D-1, D-2, D-3, D-4, D-5, D-6, D-7, D-8, D-9, D-10 in FY2027 to FY2031. Since D-1 through D-10 are currently out of service, overhaul can be done at such time as the building is back in service
- Deep clean moving walkways: D-1, D-2, D-3, D-4, D-5, D-6, D-7, D-8, D-9, D-10 in FY2027 to FY2031. Since D-1 through D-10 are currently out of service, deep cleaning can be done at such time as the building is back in service

HVAC

Much of the Concourse D HVAC equipment dates back to the original 1984 construction. The indoor central station air handling equipment is located on the apron level to serve the concourse. The AHU typically have steam and chilled water coils for heating and cooling with separate relief fans. The indoor air handlers are in fair condition.

Main steam, condensate return, and chilled water piping runs through the tunnels and mechanical rooms beneath the concourse. The physical condition of piping systems cannot be established based on visual observation alone, and assessment is based in part on airport reports of system condition. This main piping is and was reported to be in good condition, although much of the insulation is badly damaged. Branch chilled water and steam condensate piping at connections to air handlers is commonly missing insulation. Where insulation is missing, chilled water and steam piping is rusted and is in poor condition. Branch piping to rooftop units appear to be in good condition with most insulation intact.

Air distribution systems are generally in good condition. With proper humidity control in the distributed air supply, and without external physical damage, duct systems can continue in use with only periodic cleaning.

Terminal and unitary equipment on the apron level is generally in poor condition. This equipment typically has a shorter expected useful life than large central equipment. Located in mostly non-public and service areas, the terminal equipment on the apron level does not receive the maintenance attention that similar equipment in public areas might receive. Some of this equipment has failed or is operating beyond its expected useful life. Computer room air conditioners (CRAC) located in IT and communication rooms are typically in good condition, but there is no redundancy for cooling in these critical rooms.

Central AHU and RTU are controlled through an electronic digital control system monitored through the Building Automation System (BAS) by Climate Control in their Computer Lab near Climate Control East. Older pneumatic control systems and control air compressors are comingled with electronic controls and appear to be monitored by the electronic controls. The electronic controls appear and were reported to be in good condition and operating well. Digital controllers by several different manufacturers are observed suggesting potential communication incompatibility between controllers. STLAA staff confirmed the communication protocol conflict and advised that Wonderware software is being installed to integrate communications.

Recommendations

- Upgrade control systems to eliminate obsolete pneumatic controls and upgrade electronic controls to a uniform communication protocol
- Replace AHU on the apron level of the D Concourse that have reached the end of their useful life. Sixteen air handlers in Concourse D are 36 years old. Air handlers have an average life expectancy of 25 years. Air handlers in Concourse D should be replaced as required for maintenance conditioning of the unused concourse, or at such time as the concourse is reopened
- Replace RTU as they reach the end of their useful life. Two rooftop air conditioners on Concourse D are estimated to be 10 - 15 years old and are expected to require replacement in 5 – 10 years

PLUMBING

Plumbing systems on the apron level are generally in non-public areas. Fixtures and piping are assessed as fair, but several toilet groups are in poor condition due to their age and condition. Water heating equipment and appurtenances are in fair condition. Backflow preventers owned by the STLAA were inspected and tested within the past year.

Plumbing fixtures and piping on the concourse level are in poor condition due to their age and condition relative to fixtures in other public concourse areas.

Recommendations

- Identify locations where sewer back-ups have occurred in underground piping and perform video inspection of those pipe segments. While no specific such locations were identified in Concourse D, this effort should be undertaken throughout the airport where obstructions in underground sewer piping is suspected
- Upgrade piping and fixtures in restroom groups to be put into service on the concourse level of Concourse D. Shut off and drain piping to unused toilet groups in Concourse D. Stagnant water in domestic water supplies can grow bacteria which can then spread to portions of domestic water systems in use

FIRE PROTECTION

Leakage and repairs to the wet pipe sprinkler piping in 2014 led to an assessment of the sprinkler piping throughout the airport in 2015. In Concourse D, 47 percent of non-destructive piping tests performed as part of the 2015 assessment indicated interior deterioration of the sprinkler piping, and recommendations were made to prolong the life of the sprinkler pipe.

Clean agent fire suppression systems are installed in some IT and communications rooms, some of which are tenant system. All clean agent systems are in good condition and have recently been inspected.

Recommendations

- No specific fire protection recommendations apply to Concourse D. Refer to general recommendations

ELECTRICAL

Lighting

Lighting on the concourse level of D is primarily provided by four-foot fluorescent fixtures in a variety of fixture types. Waiting areas utilize one by four-foot pendant fixtures. The main corridor has pendant row fixtures, some recessed fixtures in Alkan ceilings and fluorescent strip fixtures mounted in coves along the wall. The few office spaces in Concourse D have fluorescent two by four-foot grid fixtures. There are also metal halide fixtures mounted in the skylight structures. These have been re-lamped with LED replacement bulbs. There are incandescent pendant mounted accent lights primarily in the waiting area and can-mounted uplights in the main corridor. Lighting levels in waiting areas are generally adequate, lighting down the corridor is uneven. Exit/egress lighting in Concourse D is deficient, there are several areas where no exit signage is visible. Lighting throughout the concourse looks somewhat shabby and outdated.

Power

Power is distributed to Concourse D at 4160v from the Main East substation. Four substations located throughout Concourse D transform power down to 480/277v for local distribution. The substations appear to be original equipment from the 1984 construction. Most of the distribution and branch circuit panelboards also date to original building construction and are in poor condition.

There are no substations located on the concourse level. Most of the distribution and branch circuit panelboards on the concourse level also date to original building construction and are in poor condition.

Emergency power to concourse D comes from a 1250 kw 4160/2400v generator located at the East Power plant. Two small substations transform power down to 480/277v for local distribution. The generator is in good condition, the substations are in fair condition.

Recommendations

- Replace substations older than 30 years in the five to ten-year timeframe
- Replace branch circuit breaker panels over 30 years old in a one to five-year timeframe
- Replace existing interior and egress lighting on the apron level
- Replace all lighting on the concourse level

11.2.7 Terminal 1 Parking Garage

SUBSTRUCTURE AND SHELL

The Terminal 1 Parking garage is a cast-in-place concrete structure constructed in 1971. The beams and floor slabs are all post-tensioned, however, it has been noted to WSP that the post-tensioning cables in the slabs are no longer performing as intended and are acting as normal reinforced concrete slabs. The post-tensioning in the slabs is used for crack control to prolong the life of the slab.

Multiple studies of the Terminal 1 parking garage have been performed over its life. The November 15, 2018 report titled *St. Louis Lambert International Airport 100% Complete Submittal Garage Assessments at Terminals 1 and 2* prepared by EDM Incorporated (EDM report) was used in determining the condition of the Terminal 1 parking garage. It should be noted that during the June 2020 site visits the Terminal 1 garage was briefly walked in order to verify some of the items discussed in the EDM report.

In the EDM report it was noted that the Terminal 1 parking garage had the following distress to the expansion joints:

- Cracking and signs of embrittlement of the rubber noising at the top-level expansion joints;
- Failed caulk joints between the rubber nosing and the concrete at the expansion joints;
- De-bonding of the splices at the expansion joint intersections;
- Failed compressions seals at the expansion joints between the helical ramps and the main parking garage structure.

EDM notes that these issues with the expansion joints throughout the garage are causing/allowing water infiltration into the lower floors as well as into the concrete structural members and resulting in corrosion of the steel reinforcement and delamination of the concrete at various columns, beams, and slabs. EMD noted that approximately 120 columns and 90 beams/girders throughout the Terminal 1 garage are experiencing delamination and need to be repaired. Additionally, EDM estimated approximately 5,500sqft of the surface of the concrete slabs are delaminating. At the three interior enclosed stair wells similar corrosion of the reinforcing and delamination of the concrete stairs was evident. EDM noted that repairs to the stairs were a high priority.

During the site visit, WSP noted similar distress as described in the EDM report. Several locations of seen where the concrete was delaminating from beam, columns and at the slab surface. At majority of the delamination locations corrosion and staining on the surface of the concrete were coincident which is indicative of corrosion of the steel reinforcement as discussed in the EDM report. The delamination of the concrete and corrosion of the reinforcement steel is a structural concern and these areas of distress should be repaired. Delamination of structural concrete members reduces the cross section of the member and thereby reduces its load carrying capacity. Further, any openings in the concrete will exacerbate the current problem and allow for more moisture infiltration.

Ongoing structural repairs were also observed during the site visits. Large areas of parking were sectioned off with structural shoring in place. Newer appearing concrete could be seen in some areas at some isolated

column and beams where prior repairs are assumed to have been performed. Similar, a few of the expansion joints appeared to have been replaced as well.

The Terminal 1 parking garage is in poor condition based on WSP's visual evaluation during the site visits and the review of EDM's report. The repairs as outlined in the estimate included in EDM report are adequate a should be treated as high priority. Based on the age of the structure and the current condition, WSP estimated the remaining useful life to be 5-10 years provided the repairs to the structure are made.

SERVICES

CONVEYING

Terminal 1 Garage has six hydraulic passenger elevators. The overall condition of the passenger elevators in Terminal 1 Garage is good. Elevators T1G-3 and T1G-4, installed in 1999 and 1988 respectively, are being modernized this year. Elevators T1G-5 and T1G-6, installed in 2010, and T1G-1 and T1G-2, installed in 2011, don't have any apparent issues and have many more years of useful life. Elevators in the Terminal 1 Garage, more so than other elevators in the facility, deal with continuous service calls for entrapment and luggage hitting the "call for assistance" button. STLAA staff say protective metal has been installed to try to reduce false calls for assistance.

Recommendations

- Overhaul elevators: T1G-3 and T1G-4 in FY2031-2036

MECHANICAL, ELECTRICAL, AND PLUMBING

Mechanical systems in the Terminal 1 Garage include large central exhaust fans used to ventilate the lower levels of the garage, and some small fans and unit air conditioners. These fans appear to have been installed when the garage was first built. The fans are in fair condition and being simple equipment can continue to function with maintenance on bearings and drives.

Propeller fans in the taxi queue move air to provide some cooling and dissipate some accumulate vehicle exhaust. These fans are in good condition, and provide some relief for travelers, but may not present the best impression to the travelling public.

Plumbing is limited to exposed storm water drainage piping from upper levels of the garage. Piping is in poor condition with heavy rust. Some piping, and the protective concrete barriers around piping is broken from impact or freezing. Open drainage channels on the south side of the garage are clogged with mud and weed growth.

Recommendations

- Replace failed and damaged storm drain piping and install new bollards to protect piping adjacent to drive lanes. Clean and paint all exposed piping to inhibit future corrosion
- Excavate debris in open drainage channels on the south side of the garage. Repair broken slabs and piping and install fluid applied liner to seal the channels

FIRE PROTECTION ASSESSMENT

Fire protection in the garage consists of dry standpipes that are in poor condition. Standpipe piping is badly rusted and has damaged valves and missing caps.

Recommendations

- No recommendations.

11.2.8 Terminal 2 (T2)

Terminal 2 and Concourse E opened in 1998 where Southwest Airlines is the principal tenant. Terminal 2 is a rectangular box shaped terminal capped by the E Concourse. The concourse features 18 functioning gates including three gates with domestic/international swing capability. As Southwest Airlines continued to expand, former unused gates in the D concourse have been renovated and renamed as E gates. The concourse contains Customs and Border Protection and all international arrivals are processed through Gates E29, E31 and E33. From a general architectural standpoint, Terminal 2's condition ranges from good to excellent.

SUBSTRUCTURE

Terminal 2 is a steel framed structure with a curved roof supported by steel trusses. The main supporting columns have a built-up section with two wide-flange members. The structure is framed with steel beams and columns with lateral framing provided by braced frames. The floor at the apron level is a concrete slab-on-grade and the concourse floor is a composite concrete and steel floor system. The structure is founded on spread footings of varying sizes and varying depths.

FOUNDATIONS

The foundations at Terminal 2 were generally not visible during the during the assessment site visits. During the site visits, evidence of foundation movement was not present. If the foundations had experienced movement or distress, fracturing of the concrete slabs on grade radiating from the column bases would have been evident. Additionally, distress to the architectural finishes would have been noted as well. Neither of these items were noted visibly apparent at Terminal 2 during the site visits. Terminal 2 and Concourse E were commissioned in 1998 and have been in continuous use for 22 years. Based on experience the foundations are likely in fair condition given the age and have a remaining useful life well past 10 years as long as regular maintenance is performed such as maintaining sealant at the slab joints, proper slopes are maintained at the perimeter of the structure, and proper storm water diversion is in place such as gutters, downspouts, and area drains. The proper storm water management will keep excessive moisture from infiltrating the soil adjacent to the foundations causing potential foundation issues. Currently no recommendations for repairs to the foundations is necessary.

Recommendations

- No recommendations

SLABS ON GRADE

The slabs on graded at the exterior and at the apron level of Terminal 2 are in good condition. Cracking and fracturing of the slabs were isolated and spalling and deterioration of the surface of the slab was not present. No recommendations for repairs are necessary at this time but continued monitoring and proper repairs should be made if the distress causes serviceability issues.

Recommendations

- No recommendations

SHELL

SUPERSTRUCTURE AND EXTERIOR CLOSURES

Visual observation of the interior construction and finishes revealed conditions ranging from good to excellent condition. The roof system is in good condition, only some cleaning for the skylight is needed. The only concern that has been observed is the mullion system on the east side of the building and window glasses have some broken seals.

Recommendations

- No recommendations

INTERIORS

INTERIOR CONSTRUCTION AND FINISHES

The visual observation of the interior construction and finishes revealed conditions ranging from good to excellent condition. Space on ticketing level is well maintained.

For apron level, the condition is around fair to good. Since most spaces are utilitarian spaces, a high level of finish or maintenance may not be required except for some minor fixes.

Recommendations

- No recommendations

SERVICES

CONVEYING

Terminal 2 has two hydraulic passenger elevators, two escalators, and one hydraulic passenger bag lift.

The general condition of the passenger elevators in Terminal 2 is fair. Elevators T2-1 and T2-2, installed in 1997, are nearing the end of their useful life and their doors need replacement.

The general condition of the escalators in Terminal 2 is fair. Escalators T2-3 and T2-4, installed in 1997, have power failure issues during December and January. STLAA staff say the failures have been occurring for the past three years and seem to correct themselves during mid-January.

The general condition of the bag lift in Terminal 2, T2-5, is assumed to be fair. T2-5 is included in the service agreement with Midwest Elevator, and no comments were made about its condition.

Recommendations

- Modernize elevators: T2-1 and T2-2 in FY2022 to FY2026
- Overhaul elevators: T2-1 and T2-2 in FY2022 to FY2026
- Overhaul escalators: T2-3 and T2-4 in FY2022
- Deep clean escalators: T2-3 and T2-4 in FY2022

HVAC

In Terminal 2, central station air handling equipment is located on the apron level. These include air handlers (AHU) with steam and chilled water coils serving the concourse and ticketing level, and the apron level baggage claim area. Although many have been refurbished, air handlers date back to original construction of T2 in 1998. Major equipment including air handlers are in fair condition.

Main steam, condensate return, and chilled water piping runs through the tunnels beneath the terminal. The physical condition of piping systems cannot be established based on visual observation alone, and assessment is based in part on airport reports of system condition. This main piping is and was reported to be in good condition, although some insulation was damaged or missing. Branch chilled water and steam condensate piping at connections to air handlers is commonly missing insulation. Where insulation is missing, chilled water piping is rusted due to condensation.

Air distribution systems are generally in good condition. With proper humidity control in the distributed air supply, duct systems can continue in use with only periodic cleaning. Air distribution discharges through directional nozzles in soffits. On the apron level, wall finishes around ductwork and nozzles are dirty indicating air leakage from the connection to air devices.

Terminal and unitary equipment on the apron level is generally in poor condition. This equipment typically has a shorter expected useful life that large central equipment. Located in mostly non-public areas, the terminal equipment on the apron level does not receive the maintenance attention that similar equipment in public areas might receive. Some of this equipment has failed or is operating beyond its expected useful life. Terminal and unitary equipment on the concourse and ticketing level is in better condition than that on the apron level. Door air curtains are typically functional but in poor condition. Computer room air conditioners (CRAC) located in IT and communication rooms are typically in good condition, but there is no redundancy for cooling in these critical rooms.

Recommendations

- No specific recommendations for Terminal 2. Refer to general recommendations

PLUMBING

In Terminal 2, plumbing systems on the apron level serve offices and baggage claim areas on the lower level of T2. Fixtures are mostly in public areas and are in good condition. Piping is assessed as fair. Water heating equipment and appurtenances are in fair condition. Backflow preventers owned by the airport have been inspected and tested within the past year.

Plumbing fixtures and piping on the concourse level are in good condition.

Recommendations

- Upgrade piping and fixtures in restroom groups in Terminal 2 as fixtures reach the end of their service life. Existing plumbing fixtures are 22 years old. Average plumbing fixture service life is estimated to be 30 years with plumbing trim requiring replacement approximately every 10 years

FIRE PROTECTION

Leakage and repairs to wet pipe sprinkler piping in 2014 led to an assessment of the sprinkler piping throughout the airport in 2015. In Terminal 2, none of non-destructive piping tests performed as part of the 2015 assessment indicated interior deterioration of the sprinkler piping, and recommendations were made to prolong the life of the sprinkler pipe.

Clean agent fire suppression systems are installed in some IT and communications rooms, some of which are tenant system. All clean agent systems are in good condition and have recently been inspected.

Recommendations

- No specific fire protection recommendations for Terminal 2. Refer to general recommendations

ELECTRICAL

Lighting

Lighting on the lower level is provided by 4' recessed fluorescent fixtures with replacement LED lamps in the Baggage and general circulation areas. Lighting levels are adequate. On the upper level the ticketing area has indirect wall mounted up lights with a row of 4' fluorescent lights suspended above the ticket counters. Utility spaces are generally lit with industrial strip fluorescent fixtures. Lighting in Terminal 2 is in fair condition.

Power

Power is distributed to Terminal 2 at 4160v from the Main East substation. Three substations located on the apron level of Terminal 2 transform power down to 480/277v for local distribution. The substations appear to be original equipment from the 1998 construction. Most of the distribution and branch circuit panelboards also date to original building construction and are in fair condition.

Emergency power to concourse E comes from a 1250 kw 4160/2400v generator located at the East Power plant. The generator is in good condition, the substations are in fair condition. There is a second generator located east of Terminal 2 at the flood control pump station that provides emergency power to the station pumps. This generator is in good condition.

Recommendations

- Replace fluorescent fixtures on apron level with LED fixtures

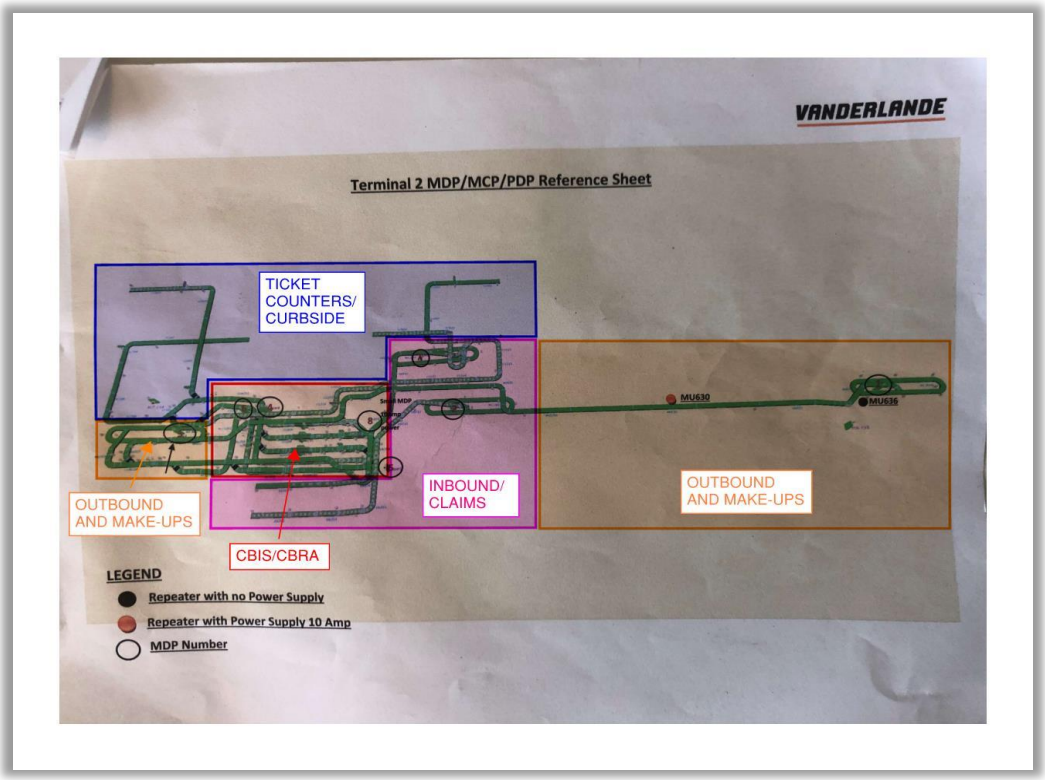
EQUIPMENT

BAGGAGE HANDLING CONVEYOR

Similar to the T1 BHS, each Terminal 2 conveyor is inspected from a mechanical, structural, electrical, safety and cosmetic standpoint, using mainly visual inspections of the various subcomponents. The equipment is also observed in operation to assess how the BHS equipment is functioning and how well the system is being maintained.

The entire outbound and inbound subsystems, including the CBIS/CBRA areas are being assessed. This also includes assessments of the motor control/distribution panels (MCPs). In total, about 320 conveyor sections and/or motor control/distribution panels are being assessed in T2. **Figure 11.2-17** shows a snapshot straight from Vanderlande's HMI of the T2 system for reference:

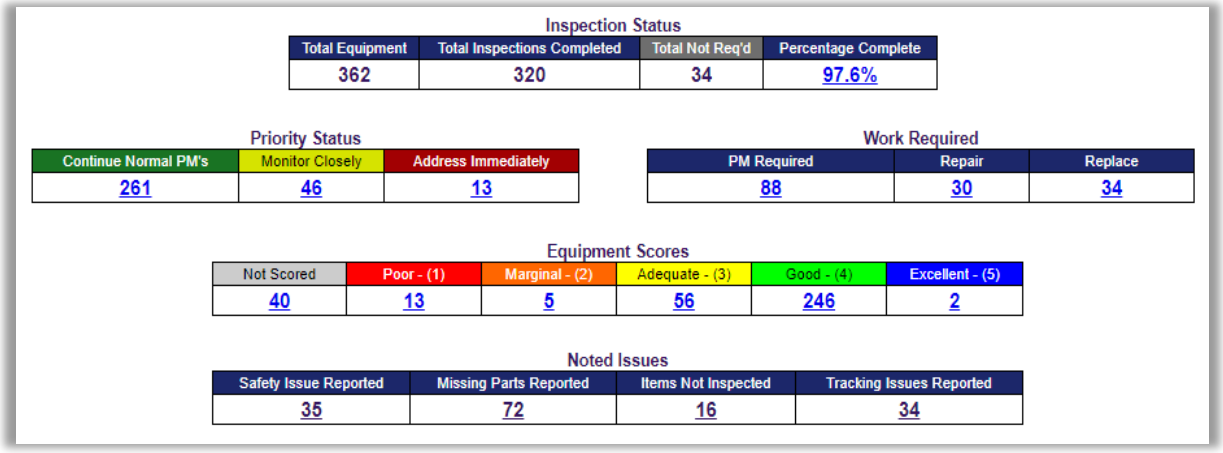
Figure 11.2-17: T2 Baggage System HMI



Source: Cage, 2021.

Of the approximate 320 conveyors, roughly 77% of those are rated as "Good" (4). Still, only about 18% of the system is rated as "Fair" (3). However, there were 13 conveyors and/or MCPs that are assessed as "Unsatisfactory" (1). There are a few instances where conveyors behind locked doors are not accessible and areas with no catwalk and therefore no rating is given. Any safety issues and any preventative maintenance requirements are also noted. **Figure 11.2-18** provides a summary snapshot of the T2 system from the proprietary BITS™ software program:

Figure 11.2-18: T2 BITS™ Summary



Inspection Status

Total Equipment	Total Inspections Completed	Total Not Req'd	Percentage Complete
362	320	34	97.6%

Priority Status

Continue Normal PM's	Monitor Closely	Address Immediately
261	46	13

Work Required

PM Required	Repair	Replace
88	30	34

Equipment Scores

Not Scored	Poor - (1)	Marginal - (2)	Adequate - (3)	Good - (4)	Excellent - (5)
40	13	5	56	246	2

Noted Issues

Safety Issue Reported	Missing Parts Reported	Items Not Inspected	Tracking Issues Reported
35	72	16	34

Source: Cage, 2021.

A majority of the components are in good condition, both electrical and mechanical components. Most of the system is functioning as intended, although a few more issues are noted than T1. Motors, reducers, PLCs, cables, photocells, and control stations a in good condition for the majority of T2. There are also common issues that are noted throughout the T2 system, and illustrated in **Figure 11.2-19, Figure 11.2-20**, **Figure 11.2-21** and **Figure 11.2-22**. Again, most of these are common industry items that are seen throughout other BHS systems across the country. Bearing caps, under carriage covers, belt tracking, belt tears, and housekeeping are just some of the items noted during the assessment.

Figure 11.2-19: T2 Transport Conveyor – Missing Bearing Caps

Source: Cage, 2021.

Figure 11.2-20: T2 Incline Conveyor -Torn Conveyor Belt

Source: Cage, 2021.

Figure 11.2-21: T2 Decline Conveyor – Safety Guard Missing

Source: Cage, 2021.

Figure 11.2-22: T2 Transport Conveyor – Belly Cover Missing

Source: Cage, 2021.

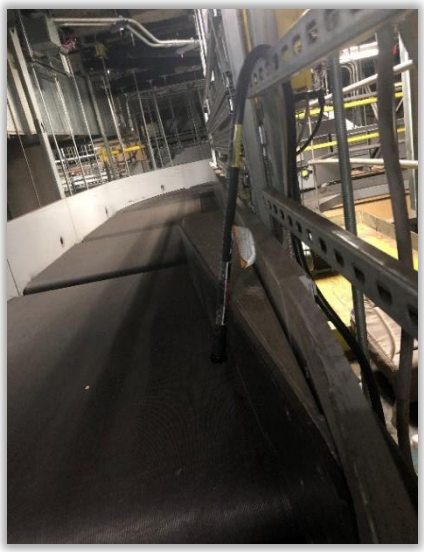
The claim unit “CD-1” inside the T2 public area is very worn. Several stainless covers are damaged and now misaligned, causing snap points and safety hazards. There are loose and exposed wires hanging from the electrical box.

The entire “TC6” ticket counter line illustrated **in Figure 11.2-23** and **Figure 11.2-24** (west side of Terminal 2) is completely shut off. Vanderlande was in the process of repairing several components along that line. Since there is no airline operating out of that side today, it is not an immediate problem. However, that could change very quickly with a new tenant. The majority of the “Unsatisfactory” ratings come from this conveyor line since it is not functioning at this time.

Figure 11.2-23: TC6-07

Source: Cage, 2021.

Figure 11.2-24: TC6-09



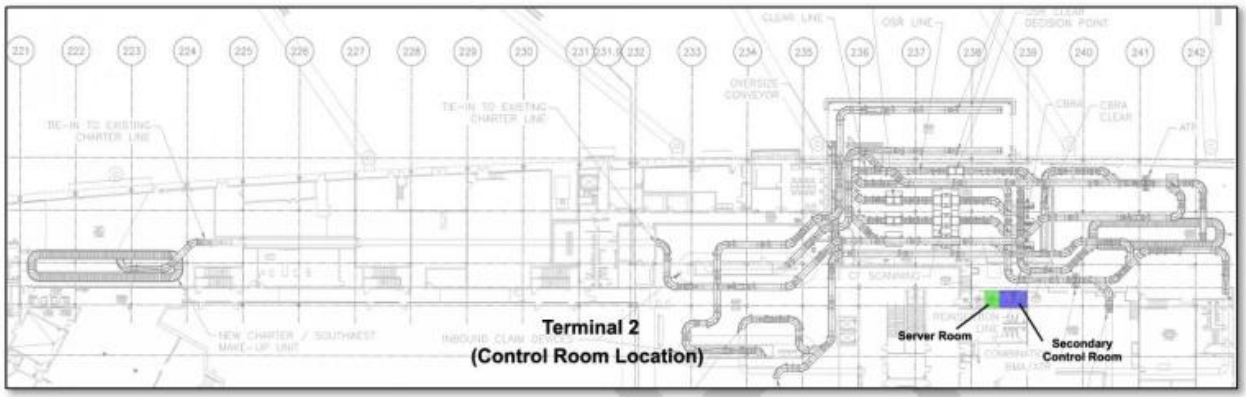
Source: Cage, 2021.

The T2 system is in slightly worse condition than T1, but it is still in good condition and within industry standards. Vanderlande appears to be maintaining the system well and therefore shall have a longer remaining useful life. It is recommended to address the safety and more critical shutdowns mentioned above as soon as possible. The safety issues were also pointed out to Vanderlande managers during the assessment and are aware of these items. It is recommended to continue with routine maintenance. In summary, the remaining useful life of the T2 system is estimated between 8 to 12 years.

T2 BHS Control Room (Remote)

The control room in T2, shown in **Figure 11.2-25** and **Figure 11.2-26**, is roughly half of the size of the T1 control room and is used as a remote/secondary control room. This control room is typically un-manned. The equipment types and models in the T2 control and server room are the same as the equipment in T1. Vanderlande management will access the workstations to reset the screen on the T1 control room from time to time.

Figure 11.2-25: Terminal 2 Control Room Location



Source: Cage, 2021.

Figure 11.2-26: Terminal 2 Control Room

Source: Cage, 2021.

The network cables in the T2 server room cabinet are not as organized in the T1 cabinet, however labeling and access for troubleshooting is manageable. The T2-HLC-WS monitor is cracked leaving the right edge of the screen distorted.

Recommendations

- No capital recommendations were identified.

11.2.9 Concourse E

Concourse E is on the north side of Terminal 2. The concourse wraps around the west side of the terminal and extends westward to concourse D. As Southwest Airlines continued to expand, former unused gates in the D concourse have been renovated and renamed as E gates. From a general architectural standpoint, Concourse E's condition ranges from fair to good.

SUBSTRUCTURE

Concourse E is situated on the backside of Terminal 2 and is constructed similarly of steel framed beam and columns and steel roof trusses. The main supporting columns are a built-up section with two wide-flange members. Lateral framing is provided by braced frames. The floor at the apron level is a concrete slab-on-grade and the concourse floor is a composite concrete and steel floor system. The structure is founded on spread footings of varying sizes and varying depths.

FOUNDATIONS

The foundations at Concourse E were generally not visible during the during the assessment site visits. During the site visits, evidence of foundation movement was not present. If the foundations had experienced movement or distress, fracturing of the concrete slabs on grade radiating from the column bases would have been evident. Additionally, distress to the architectural finishes would have been noted as well. Neither of these items were noted visibly apparent at Concourse E during the site visits. Terminal 2 and Concourse E were commissioned in 1998 and have been in continuous use for 22 years. Based on experience the foundations are likely in fair condition given the age and have a remaining useful life well past 15 years as long as regular maintenance is performed such as maintaining sealant at the slab joints, proper slopes are maintained at the perimeter of the structure, and proper storm water diversion is in place such as gutters, downspouts, and area drains. The proper storm water management will keep excessive moisture from infiltrating the soil adjacent to the foundations causing potential foundation issues. Currently no recommendation for repairs to the foundations is necessary.

Recommendations

- No recommendations.

SUBGRADE ENCLOSURES

The tunnel beneath Concourse E is in good condition. During the visual assessment several isolated cracks/fractures in the slab were noted. Representatives from the Climate Control department did not report any issues within the tunnel of concourse E. The isolated areas of distress, though minimal, should be repaired to prevent furthering of the distress and to maintain serviceable conditions in the tunnel.

Recommendations

- Removal of spalled concrete and corroded rebar and patching in new steel reinforcement and concrete. At locations where piping will impede the recommended repair, application of a coating and/or troweled grout will suffice.

SLABS ON GRADE

The slabs on graded at the exterior and at the apron level of Concourse E are in good condition. Cracking and fracturing of the slabs were isolated and spalling and deterioration of the surface of the slab was not present. The isolated areas of distress, though minimal, should be repaired to prevent furthering of the distress and to maintain serviceable conditions at the apron level and adjacent to the building.

Recommendations

- Epoxy grout injection of the cracks, and the removal of spalled/deteriorated concrete and resurfacing.

SHELL

SUPER STRUCTURE AND EXTERIOR ENCLOSURES

Visual observation of the exterior superstructure revealed conditions ranging from fair to good condition. Most part of the roof is in good condition. However, the cladding needs to have the seal maintained. For enclosure, there is some staining on metal cladding on the east elevation, and the rest parts are in good shape and might only require some cleaning work.

Recommendations

- No recommendations.

INTERIORS

INTERIOR CONSTRUCTION AND FINISHES

The visual observation of the interior construction and finishes revealed conditions ranging from fair to good condition. Concourse level is well maintained. There is no leaking point that the team can observe from the inside and no further maintenance is needed for this area.

For the apron level, the condition is around fair. Utilitarian spaces supporting the concourse level are old and might need a little fix for the cracks on walls and floors but are well functioned. Therefore, a high level of finish or maintenance may not be required except for some minor fixes. No urgent damage was found in this area.

Recommendations

- No recommendations.

SERVICES

CONVEYING

Concourse E has six hydraulic passenger elevators, and two moving walkways.

The overall condition of the passenger elevators in Concourse E is fair. Elevators E-1 and E-3, installed in 1984, are reliable but have exceeded their life expectancy. Elevator E-6, installed in 1997, E-2 and E-4, installed in 2007, have no apparent issues. E-6 is nearing the end of its remaining useful life. Elevator E-5, installed in 1997, needs cab and door improvement.

The overall condition of the moving walkways in Concourse E is poor. Moving walkways D-11 and D-12, installed in 1984, were recently shuttered due to lack of use and their handrails and step chains are near the end of their useful life.

Recommendations

- Modernize elevators: E-1 and E-3 in FY2022; E-5 and E-6 in FY2022 to FY2026; and E-2 and E-4 in FY2031 to FY2036.
- Overhaul elevators: E-1 and E-3 in FY2022; E-5 and E-6 in FY2022 to FY2026; and E-2 and E-4 in FY2031 to FY2036.
- Overhaul moving walkways: D-11 and D-12 in FY2022.
- Deep clean moving walkways: D-11 and D-12 in FY2022.

HVAC

In Concourse E, indoor central station air handling equipment is located on the apron level to serve the apron & concourse level. The air handlers (AHU) and rooftop units (RTU) typically have steam and chilled water coils for heating and cooling. The indoor air handlers were installed in approximately 1998, and are in fair condition. Some air handling equipment has reportedly been renovated since its original installation. One air handler has an access door failing and the casing around the discharge air plenum bulging outward even with external reinforcing. This condition suggests the unit is or has been operating beyond its intended operating pressure.

Main steam, condensate return, and chilled water piping runs through the tunnels beneath the concourse. The physical condition of piping systems cannot be established based on visual observation alone, and assessment is based in part on airport reports of system condition. This main piping is and was reported to be in good condition, although some insulation was damaged or missing. Branch chilled water and steam condensate piping at connections to air handlers is commonly missing insulation. Where insulation is missing, chilled water piping is rusted, in some cases badly, due to condensation.

Air distribution systems are generally in good condition. Most air distribution on the concourse level is through exposed ductwork and directional discharge nozzles. Some convector grilles at the floor level convector grilles near the exterior windows are damaged and no longer fit properly. With proper humidity control in the distributed air supply, and without external physical damage, duct systems can continue in use with only periodic cleaning.

Terminal and unitary equipment on the apron level is generally in fair condition. This equipment typically has a shorter expected useful life that large central equipment. Located in mostly non-public and service areas, the terminal equipment on the apron level does not receive the maintenance attention that similar equipment in public areas might receive. Computer room air conditioners (CRAC) located in IT and communication rooms are typically in good condition, but there is no redundancy for cooling in these critical rooms.

Central AHU and RTU are controlled through an electronic digital control system monitored through the Building Automation System (BAS) by Climate Control in their Computer Lab near Climate Control East. The electronic controls appear and were reported to be in good condition and operating well. Digital controllers by several different manufacturers are observed suggesting potential communication incompatibility between controllers. STLAA staff confirmed the communication protocol conflict with older LonWorks and newer BACnet systems and advised that Wonderware software is being installed to integrate communications.

Recommendations

- Evaluate the actual discharge static pressure and the rated operating pressure of AHU116 (AHU-1020B). Based on results of pressure testing on AHU116, and the relative air balance testing, evaluate the airflow supplied by AHU116 and the air pressure drop through distribution duct systems. Consider rebalancing to meet relative airflow and pressure requirements within rated equipment capabilities.
- Replace AHU as they reach the end of their useful life. Eight air handlers in Concourse E are 22 years old and are expected to require replacement in 5 - 10 years.

PLUMBING

In Concourse E, plumbing systems on the apron level are generally in non-public areas. Most of the plumbing fixtures are located in renovated tenant spaces occupied by Southwest Airlines and are in good condition. Plumbing piping is assessed as fair. Water heating equipment and appurtenances are in fair condition. Backflow preventers owned by the airport have been inspected and tested within the past year.

Plumbing fixtures and piping on the concourse and ticketing level are in good condition.

Recommendations

- Upgrade piping and fixtures in restroom groups in Concourse E as fixtures reach the end of their service life. Existing plumbing fixtures are 22 years old. Average plumbing fixture service life is estimated to be 30 years with plumbing trim requiring replacement approximately every 10 years.

FIRE PROTECTION

Leakage and repairs to wet pipe sprinkler piping in 2014 led to an assessment of the sprinkler piping throughout the airport in 2015. In Concourse E, none of the non-destructive piping tests performed as part of the 2015 assessment indicated interior deterioration of the sprinkler piping, and recommendations were made to prolong the life of the sprinkler pipe.

Clean agent fire suppression systems are installed in some IT and communications rooms, some of which are tenant system. All clean agent systems are in good condition and have recently been inspected.

Recommendations

- No specific fire protection recommendations for Terminal 2. Refer to general recommendations.

ELECTRICAL

Lighting

Lighting in the apron and tunnel levels of the Concourse E is generally in poor shape. The light fixtures are predominately fluorescent in these areas. Unfinished space generally utilizes fluorescent industrial strip fixtures. Lights in finished areas are a mix of recessed fluorescent fixtures. Emergency egress lighting on the apron level was deficient. Several areas had exit lights that were no longer working or that failed the pushbutton battery check test. The tunnel level of Concourse E/Terminal 2 is lit by fluorescent strip light fixtures with fixture mounted occupancy sensors. Approximately 25% of the fixtures were not working.

Lighting on the concourse level is generally in good condition. Main corridor is lit by rows of 4' linear LED lights mounted to the structural trusses from Gate E4-E24. Waiting areas for these gates are lit by a combination of 4' linear LED lights mounted to the structural trusses and LED can fixtures. Gates E29 to E40 extend into the east end of Concourse D structure. Lighting in this area is similar to Concourse D's light fixture mix except for lamps that have been replaced with LED lamps. Utility spaces are lit with fluorescent industrial fixtures.

Power

Power is distributed to Concourse Eat 4160v from the Main East substation. Two substations located on the apron level of Concourse E transform power down to 480/277v for local distribution. The substations appear to be original equipment from the 1998 construction. Most of the distribution and branch circuit panelboards also date to original building construction and are in fair condition

There are no substations located on the concourse level. Most of the distribution and branch circuit panelboards on the concourse level also date to original building construction and are in fair condition.

Emergency power to Concourse E comes from a 1250 kw 4160/2400v generator located at the East power plant. A small substation transform power down to 480/277v for local distribution. The generator is in good condition, the substation is in fair condition.

Recommendations

- Replace fluorescent fixtures on apron level with LED fixtures.

11.2.10 Customs and Border Protection / Federal Inspection Service (CBP/FIS)

SUBSTRUCTURE

The foundations, subgrade enclosures, and slabs on grade as the related to the Federal Inspection Service facility are discussed under the Concourse E section of this report.

SHELL

The superstructure related to the Federal Inspection Service facility is discussed under the Concourse E section of this report.

INTERIORS

INTERIOR CONSTRUCTION AND FINISHES

The apron level fully houses all functions of the currently operational FIS. Constructed in 2006, the space is only slightly over ten years old. Minor wear and abuse to wall and floor finishes and some casework is present, but no major aesthetic, functional, or hygienic issues are readily present. Walls are largely clad with vinyl wall coverings and metal panel wainscoting. The floor finish at the baggage carousel, the restrooms, and exit is a ceramic or porcelain tile, offices and inspection areas are carpeted, and the detention area is surfaced with a monolithic, resinous material. The secondary inspection area is separated via translucent, demountable partitions which appear clean and like-new. These should be readily removable and or reconfigurable in any future airport construction.

The concourse level extents for Site E are not directly over the apron level extents; they are offset, west and opposite of the central mechanical plant cooling tower. The area included, constructed as a temporary hold room, is currently not in use and enclosed with a temporary partition. It contains tools, construction materials and unused furniture.

The finishes are dated, dilapidated, dirty, and worn. Light-duty commercial carpeting covers the floor and walls and is stained, torn, and covered with debris. The underside of the roof deck and its support structure is exposed to view and painted a dark bronze color in keeping with the previous airport aesthetic scheme.

Recommendations

- Consider renovations/repairs of the apron level where safety issues are a concern due to dilapidated conditions.
- At the concourse level, finished of the CBP are generally in good condition and no additional maintenance needed at this time.

SERVICES

CONVEYING

There are no conveying systems in this area.

HVAC

The Customs and Border Protection and Federal Inspection Service is conditioned by indoor central station air handling equipment located on the apron level. The air handlers (AHU) have steam and chilled water coils for heating and cooling supplied from Climate Control East. The indoor air handlers were installed in approximately 1998 and are in fair condition.

Main steam, condensate return, and chilled water piping runs through the tunnels beneath the apron level. This main piping is and was reported to be in good condition, although some insulation was damaged or missing. Branch chilled water and steam condensate piping at connections to air handlers is commonly missing insulation. Where insulation is missing, chilled water piping has rusted, in some cases badly, due to condensation.

Air distribution systems are generally in good condition. Air distribution is through concealed ductwork above a dropped ceiling. With proper humidity control in the distributed air supply, and without external physical damage, duct systems can continue in use with only periodic cleaning.

Terminal and unitary equipment in the CBP/FIS area is in good condition. This equipment typically has a shorter expected useful life that large central equipment, but the terminal equipment in this area is somewhat newer that that in the adjacent Concourse D and Terminal 1 apron level.

Central AHU and RTU are controlled through an electronic digital control system monitored through the Building Automation System (BAS) by Climate Control in their Computer Lab near Climate Control East. The electronic controls appear and were reported to be in good condition and operating well. Digital controllers by several different manufacturers are observed suggesting potential communication incompatibility between controllers. STLAA staff confirmed the communication protocol conflict with older LonWorks and newer BACnet systems and advised that Wonderware software is being installed to integrate communications.

Recommendations

- Replace AHU as they reach the end of their useful life. Eight air handlers in Customs and Border Protection are 36 years old and have exceeded their expected service life. Air handlers in Customs and Border Protection should be replaced as required to maintain the unused space, and all air handlers should be replaced when the area is put back in service.

PLUMBING

Plumbing fixtures in the CBP/FIS area are in fair to good condition. Plumbing piping is assessed as fair. Water heating equipment and appurtenances are in fair condition.

Recommendations

- Upgrade piping and fixtures in restroom groups to be put into service in the Customs and Border Protection Area. Shut off and drain piping to unused toilet groups in CBP. Stagnant water in domestic water supplies can grow bacteria which can then spread to portions of domestic water systems in use.

FIRE PROTECTION

The CBP/FIS area is protected throughout with automatic wet pipe fire suppression sprinklers that appear to be in good condition. The area also has Class 3 standpipe and hose cabinets installed that are in fair condition.

Testing was performed on sprinkler piping throughout the airport in 2014 and 2015. At that time, no corrosion was found in fire protection piping in Terminal 2 or Concourse E. Sprinkler piping in the CBP/FIS is expected to be in good condition.

Recommendations

- No specific fire protection recommendations for Customs and Border Protection. Refer to general recommendations.

ELECTRICAL

Lighting

Lighting in the Terminal 2 CBP/FIS area is provided by recessed 2’ x 4’ and 2’ x 2’ fluorescent fixtures with LED relamp. The inspection area has recessed LED fixtures. There is extensive fluorescent cove lighting around the perimeter of the space. Lights are in fair shape while cove lights in poor shape.

Power

Power distribution is from branch circuit panelboards and are in fair condition.

Recommendations

- Replace all cove lighting in Terminal 2 CBP/FIS area.

EQUIPMENT

BAGGAGE HANDLING SYSTEMS

The baggage system within the FIS consists of 10 conveyors and a claim unit. These conveyors are II-01, II-02, II-02 FD, II-03, II-04, II-05, II-06, II-07, II-07 FD, II-08. The bag claim unit is used daily. The amount of traffic is seasonal and typically ranges between two to four arriving flights per day. The two load conveyors that are outside and exposed to the elements are obviously more worn but are still in fair condition. The only issues noted were typical bearing caps missing and rusted frames of the two load

conveyors located outside. Upon noticing that the fire door was not shutting properly, Vanderlande was notified immediately. The issue was then resolved by Vanderlande within the hour. Overall, the system is functioning well and is in good condition. The remaining useful life of this system is estimated to be greater than 10 years.

Recommendations

- No recommendations.

11.2.11 Terminal 2 Parking Garage

SUBSTRUCTURE AND SHELL

The Terminal 2 Parking garage is a combination pre-cast and post-tensioned concrete structure. The columns and shear walls are cast-in place steel reinforced structural elements. The beams and floor slabs are post-tensioned structural elements. The exterior is clad with panels that are precast and connected to the main structures with welded angles at embedded connection plates.

Multiple studies of the Terminal 2 parking garage have been performed over its life. Specifically, the November 15, 2018 report titled St. Louis Lambert International Airport 100% Complete Submittal Garage Assessments at Terminals 1 and 2 prepared by EDM Incorporated (EDM report) are used in determining the condition of the Terminal 2 parking garage. The Terminal 2 garage was observed outside of the scheduled two weeks of site visits for the FCA. The additional site visit was performed in order to verify some of the items covered in the EDM report.

In the EDM report it was noted that the expansion joints are in good condition throughout. The concrete columns throughout the garage were in good shape. EDM found two issues with columns. The first issue was some tension cracking on the face of some columns. There was no structural concern for the cracking other than the possible entryway for water. It was observed that at one column water had entered through a tension crack and started to corrode the steel reinforcement resulting in concrete delamination. The second issue was cracking around some of the embedded precast connection plates. EDM stated that where the cracking was severe that repairs should be performed to restore the connection structural capacity.

The EDM report states that the concrete beams and the slabs were in generally good condition. Minor issues were noted where cracking was seen at embedded steel plates in the post-tensioned beams. Minor cracking and delamination were noted at the post-tensioned slabs. EDM noted corrosion in varying degrees at the steel embedded connection plates for the precast panels.

WSP's observations during the additional site visit verified all the items discussed in the EDM report. Minor cracking was seen throughout and isolated delamination. It was unclear if some of the repairs outlined in the EDM report had already been performed prior to WSP's walk through of the garage.

Based on WSP visual observations and a review of the EDM report, WSP believes the Terminal 2 Garage is in good condition with only minor repairs needed to maintain the structure. The repairs as outlined in the estimate included in EDM report are adequate a should be treated as low priority. Based on the age of the structure and the current condition, WSP estimated the remaining useful life to be beyond 10 years provided the repairs to the structure are made.

SERVICES

CONVEYING

Terminal 2 Garage has four hydraulic passenger elevators. The overall condition of the passenger elevators in Terminal 2 Garage is fair. Elevators T2G-1, T2G-2, and T2G-3, installed in 1997, have no apparent issues

but are nearing the end of their useful life. Elevator T2G-4, installed in 1998, has severe rust issues on its cab and sling, and its sills are exposed to the elements leading to issues after the winter season. Elevators in the Terminal 2 Garage, more so than other elevators in the facility, deal with continuous service calls for entrapment and luggage hitting the “call for assistance” button. STLAA staff say protective metal has been installed to try to reduce false calls for assistance.

Recommendations

- Modernize elevators: T2G-1, T2G-2, T2G-3 in FY2022 to FY2026; and T2G-4 in FY2027 to FY2031.
- Overhaul elevators: T2G-4 in FY2022; and T2G-1, T2G-2, T2G-3 in FY2022 to FY2026

MECHANICAL

The Terminal 2 Garage is an open garage and has no general mechanical equipment. An air conditioning unit in the staff restroom on the south side of the garage is in fair condition.

Infrared radiant heaters on the upper level are in poor condition but are functional.

Recommendations

- No recommendations.

PLUMBING

Plumbing consists of storm drains and piping from upper levels. Drains and piping are in fair to good condition. Piping runs vertically down and then horizontally along beams on the lower level. At least one horizontal piping segment at a pedestrian walkway had apparently been hit by a vehicle, and repaired. The vehicle may have mistaken the walkway as a drive lane or parking space.

Recommendations

- Install physical barriers to vehicle traffic to protect vertical piping and piping too low for vehicle clearance.

FIRE PROTECTION

Fire protection consists of dry standpipes which are in fair condition.

Recommendations

- No specific fire protection recommendations for the Terminal 2 Garage.

ELECTRICAL

Lighting

Lighting in the Terminal 2 East garage is provided by surface mounted LED fixtures and pole mounted LED fixtures on the roof deck. Interior garage signage typically has linear LED accent lighting. Fixtures are generally in fair shape and lighting levels appear adequate. Exit lights are in poor condition.

Recommendations

- Replace exit lights.

11.2.12 Climate Control - West

SUBSTRUCTURE

FOUNDATIONS

The foundations at Climate Control West were generally not visible during the during the assessment site visits. During the site visits, evidence of foundation movement was not present. If the foundations had experienced movement or distress, fracturing of the concrete slabs on grade radiating from the column bases would have been evident. Additionally, distress to the architectural finishes would have been noted as well. Neither of these items were noted visibly apparent at the Climate Control West building during the site visits. The foundations are anticipated to be some combination of concrete piers and spread footings and are likely in fair condition given the age. This would provide a remaining useful life well past 15 years as long as regular maintenance continues to be performed, including maintaining sealant at the slab joints, maintenance of proper slopes at the perimeter of the structure, and proper storm water diversion is sustained such as gutters, downspouts, and area drains. Proper storm water management will keep excessive moisture from infiltrating the soil adjacent to the foundations causing potential foundation issues. Currently no recommendations for repairs to the foundations is necessary.

SLABS ON GRADE

The concrete slabs on grade at Climate Control West are in fair condition. Cracking and fracturing of the slabs are present throughout the building. Spalling and deterioration of the surface of the slab was in isolated locations usually adjacent to drains and mechanical equipment where water and other liquids were leaking or being used. While these conditions do not cause any reduction in the slab's structural capacity, if left in its current state the distress will accelerate and cause serviceability issues in the future.

Recommendations

- Epoxy grout injection of the cracks, and the removal of spalled/deteriorated concrete and resurfacing.

SHELL

SUPER STRUCTURE

The steel super structure of the Climate Control West facility is in fair condition and no major issues with structural elements of the super structure are observed. Some of the columns exhibit corrosion usually near the baseplate connection. Based on the age of the structure and the current condition, the estimated remaining useful life is well beyond ten years given proper maintenance. The steel connections should be routinely inspected by a licensed professional with special attention given to those locations that are exposed to the elements.

Recommendations

- Recommended repairs to the steel members that exhibit corrosion include grinding away the corrosion at and painting the steel with a weather proofing paint.

SERVICES

CONVEYING

There is no conveying in this area.

Recommendations

- No recommendations.

MECHANICAL

The two airport central utility plants are identified as Climate Control West (CCW), and Climate Control East (CCE). Climate Control West is in a stand-alone building west of Terminal 1. CCW provides most of the heating and cooling capacity for Terminal 1, concourses A-D, and some remote airport buildings. CCW provides the steam used to generate domestic hot water for Terminal 1 and concourses A-D in heat exchangers in CCW and distributed through the terminal and concourses. CCW also has the ability to serve as a back-up heating and cooling source for CCE. Unlike the Heating ventilating and air conditioning (HVAC) systems for the terminal and concourses which consist largely of air handlers and building air distribution systems, the HVAC systems assessed in Climate Control West consist of large central steam boilers, condensate deaerators, water chillers, cooling towers, and the distribution pumps to circulate condenser water to cooling towers and chilled water to the terminals and concourses.

During the visual observations of the condition of equipment in the Climate Control plants, building HVAC systems for the plant, such as air handlers, distribution and terminal equipment were observed, but the emphasis was on the central equipment supplying heating, cooling, and domestic hot water to the terminals. Preliminary assessments were made of the large central equipment, and the piping networks supplying the terminals.

The east and west Climate Control plants are built so that either plant can serve the entire airport if one plant is disabled. This capability requires manual changeover, but the capability should be considered in any assessment of the capacities of either plant.

Heat and cooling generating systems appear to be maintained well and have been upgraded periodically through capital improvement projects.

Heat in the terminals and concourses is provided by steam. Steam is generated in CCW by three fire-tube boilers and one water-tube boiler. The three fire-tube boilers were installed in 2008 and are in good condition. The water-tube boiler was installed in 1990 and is in fair condition. The boiler capacity is considered adequate with the larger water-tube boiler having capacity to handle the heating load on most days. Smaller boilers are used to supplement capacity, for lower warm weather demand, and for standby

capacity. The feedwater system for the boilers includes condensate storage tanks, and a feedwater deaerator. The deaerator was replaced in 2019 and is in excellent condition, and the condensate tanks were reported to be in good condition.

In CCW, three chillers produce chilled water for air conditioning in the terminal and concourses. One chiller was installed in 2019 and is in excellent condition. Two chillers were installed in 2002 and are considered to be in fair condition but are operating reliably. STLAA staff reported that on hot days, CCW uses up to 70% of the installed chiller capacity, but that the total plant cooling capacity is limited by the capacity of the cooling towers.

Three chilled water pumps were installed in CCW in 2019 and all are in excellent condition. STLAA reported that they have excess pressure drop through the chilled water system, particularly with Chiller #3, and that the pressure drop can make it difficult to cool more remote areas of the terminal and concourses.

The cooling towers serving the three chillers in CCW were installed in 1986 and are reportedly in poor condition. A capital improvement project is in progress to rehabilitate the cooling towers and to replace the lining in the cooling tower basins.

Three condenser water pumps transfer water between the cooling towers and chillers. The condenser water pumps were installed in 1984. The pumps reportedly operate reliably but then have also reportedly been rebuilt “a couple of times” and the strainer baskets have deteriorated.

Water Treatment systems in CCW appear and were reported to be in good condition and effective. Piping in CCW and the associated tunnels is in fair condition. STLAA staff reported that visual inspection of piping removed to allow repairs to various equipment and components showed the piping to be in good condition with little corrosion. No systemic problems were reported with system piping, although some problems with older expansion joints and flanges were reported and are repaired as they are discovered. STLAA staff expressed some concern for the reliability of fiberglass pipe used to repair some sections of pipe in tunnels, but no specific failures were reported.

The central domestic water heat exchanger and pumps for T1, and the water softener in CCW are obsolete and in poor condition. The water heater dates back to the original construction in 1953.

Recommendations

- Replace Domestic hot water heat exchangers and circulating pumps.
- Replace the water softener system.
- Replace condenser water pumps. The three condenser water pumps are 36 years old, and centrifugal pumps have a life expectancy of 20 years. The three pumps have been rebuilt, but the entire pump assemblies are expected to require replacement.
- Assess the capacity of cooling towers relative to historical cooling load with consideration for cooling tower rehabilitation currently planned as a capital improvement. The chillers in Climate Control West are reportedly rarely loaded over about 60%, but limited cooling tower capacity reportedly limits the cooling capacity of the Climate Control West chilled water plant. Planned cooling tower rehabilitation will improve the cooling tower performance but may not raise the capacity to a level preferred to allow for redundancy. Redundancy needs to be included in capacity calculations to account for unexpected failure of one or more cooling tower cells. The capacity of the chilled water plant also needs to consider the combined load of terminals T1 and T2 since Climate Control West can serve as back-up for the chilled water plant in Climate Control East, and vice-versa. If the projected capacity with the cooling tower improvements in place is inadequate, expansion of the cooling towers on the existing basins, or installation of a fourth cooling tower cell should be added as a future capital improvement.
- Perform a pressure drop study of the chilled water system from CCW to the remote extents of the chilled water system to assess locations within the piping network with high water pressure drop. Testing of the water pressure drop through select equipment or pipe sections should be included in the assessment.
- Based on results of the water pressure drop study, revise select piping segments to improve chilled water flow.
- Replace one water tube boiler and controls. The one remaining water tube boiler in Climate Control West is 30 years old, and water tube boilers have an average service life expectancy of 25 – 30 years.
- Replace 1500T Chillers #1 & #3 when they reach the end of their service life. Two of the three chillers installed are 18 years old and are expected to require replacement in 5 – 10 years.
- Replace Fuel Oil Tanks

ELECTRICAL

Electrical assessment in this area includes (1) the main mechanical-electrical (climate) spaces, (2) the electric shop, and (3) the connecting administrative offices. Only visual observations were possible, so perceived age of the equipment played a large role in the condition classification of electrical equipment and devices. Visual observation is limited in that it cannot identify hidden issues, such as overloaded conditions, worn or corroded parts, or circuit breaker trips that no longer function as new.

The main mechanical-electrical space encompasses the main medium voltage switchgear, a unit substation, both medium and low-voltage motor control centers, three variable frequency drives serving

water pumps, switchboards and panelboards, two dry type transformers, plus general illumination LED luminaires.

The space is kept relatively clean, although there were several housekeeping issues related to obstructing free access to electrical equipment. The most noticeable was a refrigerant pump-down unit stored directly in front of two motor control centers.

The space has a fusible switchboard of older vintage but, visually, it appears to have no issues. Fuses do not degrade like molded case breakers, so the older unit should provide good service for years.

However, several of the low voltage panelboards are older vintage and should be considered for replacement within the next 5-10 years. Trip characteristics of molded case breakers degrade with age.

Several disconnects serving pumps with full-voltage starters are older vintage and NEMA 1. The immediate area where installed is dirty and the application may have been more suited for an enclosure more resistant to the dirty environment. They should be considered for replacement within five years.

The space uses approximately four VFDs for pumps. They appear to be in good to excellent condition. Expected life of a VFD is more limited than other electrical controls, particularly in harsher environments, and these VFDs should provide good service for 5-10 years.

The remaining equipment appears to be relatively recent vintage and the airport should not expect to consider replacement within the next ten years. Further, Airport maintenance reports that medium voltage gear is subject to regularly scheduled maintenance.

General illumination appears to be relatively new LED luminaires and should not require complete replacement within the next ten years. Luminaires in the adjoining administrative offices, which include a kitchen/breakroom, office, conference, and storage spaces appear to be fluorescent troffers. For energy efficiencies, the airport may wish to consider LED upgrade as soon as practical. Many of the luminaires in electric storage appear to have been upgraded to LED.

Wall and counter receptacles appear older. In addition, receptacle quality is not evident, such as federal-spec grade, or whether they are equipped with push-in terminals. Further, there appears to be a general shortage of receptacles. Several places were observed to have receptacles with potentially hazardous overload conditions i.e. loaded with multi-outlet plug-ins and connected outlet strips; the most egregious appears to be in the electric storage locker room.

Recommendations

- Replace substations over 30 years old in a in a five to ten-year time frame.
- Replace branch circuit breaker panels over 30 years old in a one to five-year timeframe.

11.2.13 Climate Control - East

SUBSTRUCTURE

The foundations, subgrade enclosures, and slabs on grade as the related to the Climate Control East facility are discussed under the Concourse D section of this report.

SHELL

The superstructure related to the Climate Control East facility is discussed under the Concourse D section of this report.

SERVICES

CONVEYING

There are no conveying systems in this area.

MECHANICAL

The two airport central utility plants are identified as Climate Control West (CCW), and Climate Control East (CCE). Climate Control East is on the apron level near the west end of Concourse E. CCE provides most of the heating and cooling capacity for Terminal 2, Concourse E, and part of Concourse D. CCE provides the steam used to generate domestic hot water for Concourse E in heat exchangers in CCE and in the concourse. CCE also has the ability to serve as a back-up heating and cooling source for CCW. Unlike the Heating ventilating and air conditioning (HVAC) systems for the terminal and concourses which consist largely of air handlers and building air distribution systems, the HVAC systems assessed in Climate Control East consist of large central steam boilers, condensate deaerators, water chillers, cooling towers, and the distribution pumps to circulate condenser water to cooling towers and chilled water to the terminals and concourses.

During the visual observations of the condition of equipment in the Climate Control plants, building HVAC systems for the plant, such as air handlers, distribution and terminal equipment were observed, but the emphasis was on the central equipment supplying heating, cooling, and domestic hot water to the terminals. Preliminary assessments were made of the large central equipment, and the piping networks supplying the terminals.

The east and west Climate Control plants are built so that either plant can serve the entire airport if one plant is disabled. This capability requires manual changeover, but the capability should be considered in any assessment of the capacities of either plant.

Heat and cooling generating systems appear to be maintained well and have been upgraded periodically through capital improvement projects.

Heat in the terminals and concourses is provided by steam. Steam is generated in CCE by three water-tube boilers installed in 1984. Two of the boilers are in poor condition and have required multiple recent repairs. All three boilers have outdated analog controls. The boiler capacity is considered adequate with

the smaller boiler being used most frequently to handle loads on moderate days. The feedwater system for the boilers includes condensate storage tanks, and a feedwater deaerator. The deaerator was replaced in 2018 and is in excellent condition, and the condensate tanks were reported to be in good condition.

In CCE, three chillers produce chilled water for air conditioning in the terminal and concourses. Chillers were installed in 1985, 1998 and 2017 and range from poor to excellent condition. STLAA staff reported that on hot days, CCE uses up to 70% of the installed chiller capacity, but that the total plant cooling capacity is limited by the capacity of the cooling towers. Four chilled water pumps were installed in CCE in 2020 with one being redundant. All chilled water pumps are in excellent condition.

Four cooling tower cells in a single structure serve the three chillers in CCE. The towers were installed in 1996 and are reportedly in fair condition. One baffle reportedly needs to be replaced, and one tower fan needs to be repaired, but these repairs are reportedly scheduled to be completed.

Five condenser water pumps, one of which is redundant, were installed in 2020 to transfer water between the cooling towers and chillers. The pumps are in excellent condition.

Water Treatment systems in CCE appear and were reported to be in good condition and effective. Piping in CCE and the associated tunnels is in fair condition. The airport reported that visual inspection of piping removed to allow repairs to various equipment and components showed the piping to be in good condition with little corrosion. No systemic problems were reported with system piping, although some problems with expansion joints and flanges were reported and are repaired as they are discovered. STLAA staff expressed some concern for the reliability of fiberglass pipe used to repair some sections of pipe in tunnels. Fiberglass pipe reportedly pulled away from one flange in a tunnel to the cooling tower, but no other specific problems were reported with the fiberglass pipe.

Recommendations

- Repair one cell of the cooling tower that is currently out of service, and critically assess the condition of the remaining three operational cells.
- Replace the three water tube boilers, analog boiler controls, and the condensate return tanks.
- Replace 1300T Chiller #1
- Replace Fuel Oil Tanks

ELECTRICAL

The main mechanical-electrical space encompasses the main medium voltage switchgear, four-unit substations, both medium and low-voltage motor control centers, eighteen variable frequency drives serving chillers and water pumps, switchboards and panelboards, four dry type transformers, plus general illumination LED luminaires. Only visual observations were possible, so perceived age of the equipment played a large role in the condition classification of electrical equipment and devices. Visual observation is limited in that it cannot identify hidden issues, such as overloaded conditions, worn or corroded parts, or circuit breaker trips that no longer function as new.

There were several housekeeping issues related to obstructing free access to electrical equipment. The most noticeable was an electrical parts cart stored directly between two facing cabinets of medium voltage switchgear.

The main medium voltage switchgear is of older vintage and four of seven buckets are labeled 'out-of-service'. Airport maintenance reports that the buckets are simply disconnected rather than non-functional. Further, Airport maintenance reports that medium voltage gear is subject to regularly scheduled maintenance and many breakers have been replaced over the years. With good maintenance, this medium voltage gear should continue to provide good service for more than ten years.

There are four pairs of panelboards (480 and 208-volt) that are interconnected through a dry transformer. Two pairs are of older vintage and should be considered for replacement within five years. The remaining two pairs, and the other panelboards in the space, are newer vintage and should provide good service for more than ten years.

Of the four-unit substations, only one appears to be of recent vintage and should provide good service for more than ten years. The remaining three-unit substations are much older vintage and some of the accessories appear to be nonfunctioning. Airport maintenance reports that medium voltage gear is subject to regularly scheduled maintenance; if these unit subs are among them, the generally poor appearance may not necessarily suggest that they are candidates for replacement in the next 5-10 years.

The space has a fusible switchboard of older vintage but, visually, it appears to have no issues. Fuses do not degrade like molded case breakers, so the older unit should provide good service for years.

Among the eight motor control centers (MCCs) in the space, two are medium voltage—one of which was observed to be out of service. The remaining medium voltage MCC appears to be in fair condition and continue service for 5-10 years. There are six low voltage MCCs—four of which are older vintage and in fair condition. The Airport may wish to consider upgrading the individual controllers or outright replacement within 5-10 years. The remaining two low voltage MCCs are newer vintage that should provide good service for more than 10 years.

The space uses approximately 18 VFDs for pumps or chillers. They appear to be in good to excellent condition. Expected life of a VFD is more limited than other electrical controls, particularly in harsher environments, and these VFDs should provide good service for 5-10 years.

It appears that the Airport replaced most of the general illumination in the space with new LED luminaires relatively recently and should not require complete replacement within the next ten years.

Recommendations

- Replace substations over 30 years old in a five to ten-year timeframe.
- Replace branch circuit breaker panels over 30 years old in a one to five-year timeframe.

PLUMBING

Recommendations

- No recommendations.

11.2.14Sitework

ROADWAYS AND BRIDGES

The existing Airport roadway system is depicted in **Figure 11.2-27**.

Figure 11.2-27: Airport Roadway map

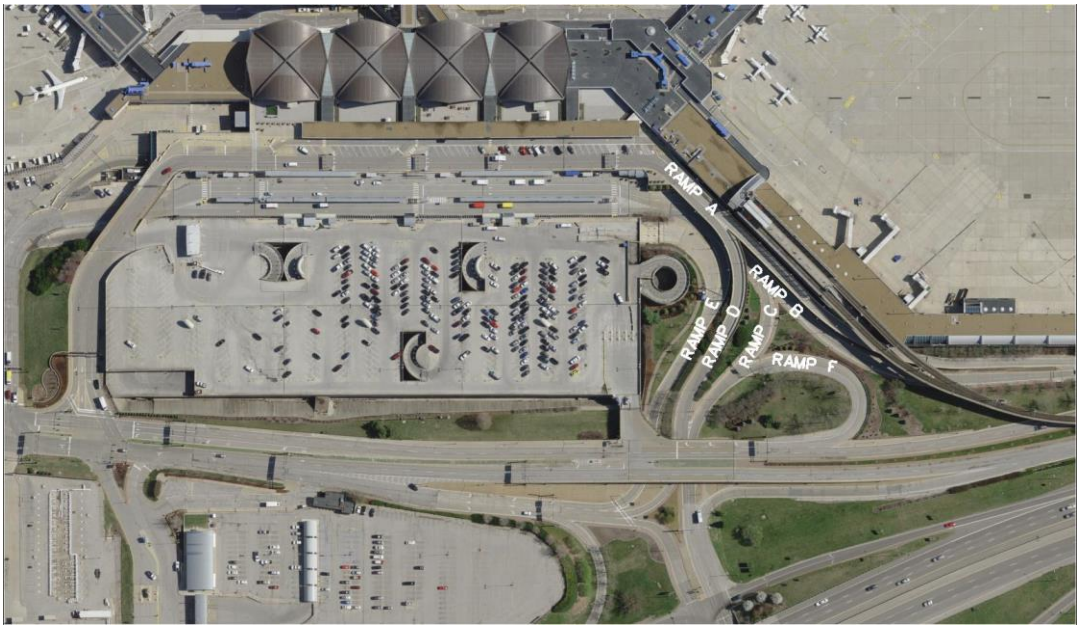
Source: EDSI, 2021.

TERMINAL 1

Arrivals Drive Roadway

The current configuration of the Arrivals Drive (formerly Baggage Claim Drive) developed over several years. Ramps B, C, and E; Arrivals Drive in front of Terminal 1 (the main part); and Arrivals Drive (exit roadway) extending to the southwest to Lambert International Boulevard (LIB) are included within the limits of Arrivals Drive. The main part of Arrivals Drive was part of the construction of the Terminal 1 parking garage (labeled Lower Level Drive) around 1970. Ramps B, C, and E were built as part of the Access Roadways Phase II project in the late 1980s. Arrivals Drive consists of a concrete pavement section on grade and a bridge in front of Terminal 1. Terminal 1 Arrivals Drive and associated ramps is illustrated in **Figure 11.2-28**.

Figure 11.2-28: T1 Arrivals Drive Ramps

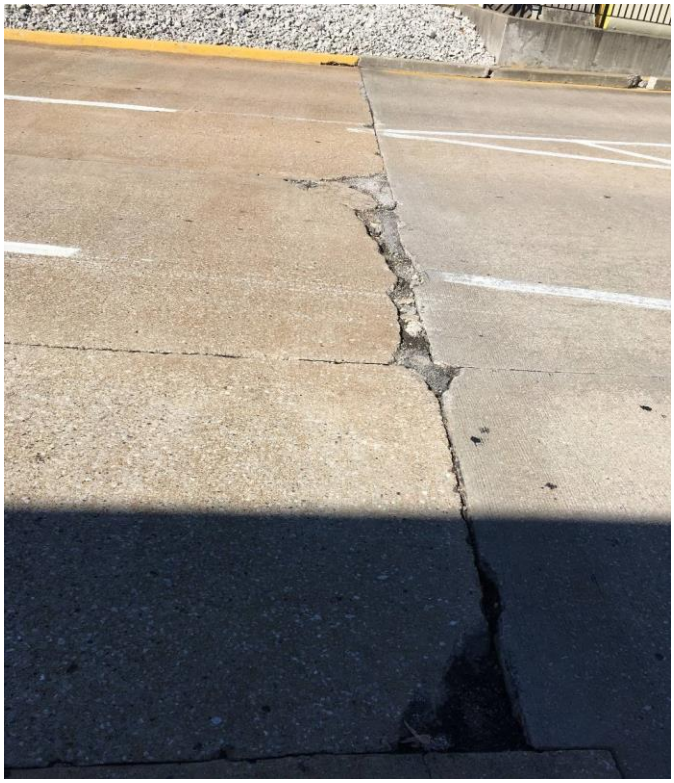


Source: EDSI, 2021.

The entrance roadway ramps, Ramps B, C, and E, are in a similar state of deterioration and exhibit the following conditions. Pavement cracks are visible throughout, with the pavement and/or curbs and curb inlets exhibiting deterioration at several locations, as shown in **Figure 11.2-29**. The paint on the curbs is worn or scraped off at numerous locations. The pavers immediately behind the curb, which were originally intended as salt spray protection, exhibit settlement or are missing, allowing soil and debris to accumulate behind the curbs. These pavers are undermined in several places and are noticeably uneven. There are also several signs which have been damaged by traffic and/or are non-reflective.

The main part of Arrivals Drive exhibits numerous issues with respect to roadway/civil infrastructure. The island curbs that separate traffic lanes are seriously deteriorated in numerous places. Several pavement areas exhibit ponding of rainfall along the curb lines that present a safety concern and will accelerate pavement and curb deterioration. Several signs are not reflective and/or are obscured by other signs. Two conflicting sets of pavement striping are superimposed in several locations, potentially causing confusion for drivers and pedestrians. The paint on the underside of the shelter canopy adjacent to the shuttle bus lane is peeling. In addition to being unsightly, the peeling paint has the potential to drop paint onto passengers waiting for a bus and may allow rust to more easily form on the exposed steel, shortening the remaining service life of the canopy. The pavement is deteriorating in several places from the west end of the main part of Arrivals Drive (exit roadway) extending to LIB. The lighting is generally in satisfactory condition; however, some age-related deterioration of the posts and fixtures is evident.

Figure 11.2-29: Arrivals Drive – Deteriorated Pavement and Curb



Source: EDSI, 2021.

Recommendations

- Refer to Effective Remaining Useful Life Section.

Arrivals Drive Bridge

The Arrivals Drive Bridge was most likely built with the Terminal 1 parking garage structure in approximately 1970. Construction plans are not available. The bridge appears to consist of a 2-way concrete "waffle" slab supported on concrete columns. The concrete includes both conventional and post-tensioned steel reinforcement, depending on the location. Based on previous investigations, the effectiveness of the post tensioning is unknown. The concrete columns were reinforced to address concerns about shear capacity as part of a rehabilitation project in 2013 (Letting Number 8528). The slab, illustrated in **Figure 11.2-30**, was patched as needed to repair deterioration along the (visible) length of the bridge at a similar time. Additionally, an overlay was recently applied to the bridge deck riding surface. Offices and pedestrian passageways are located directly below the bridge slab within the middle third of the bridge. In this region, the underside of the slab is not accessible for visual observation. The Red Level of the parking garage, which is accessible, is underneath the end thirds of structure.

The wearing surface exhibits minor cracking and the joints are deteriorated. Evidence of water leaking through joints is visible on the underside of the slab, including at both abutments (end supports). At the eastern abutment, some spalling of concrete is present. Water leakage through the joint may be the cause of the spalling. In addition, the cementitious fireproofing on several of the steel columns installed during the 2013 rehabilitation project is coming off, leaving exposed steel which is starting to show surface rust.

Figure 11.2-30: Arrivals Drive Bridge Slab (underside) showing previous patches and efflorescence

Source: EDSI, 2021.

Recommendations

- Refer to Effective Remaining Useful Life Section.

Departures Drive Roadway

The Departures Drive Roadway (formerly Ticketing Drive) consists of Ramps A and D, the portion of Departures Drive which is adjacent to the Terminal 1 ticketing area (the main part), and the western end of Departures Drive (exit roadway) where traffic exits to LIB. The main part of Departures Drive and parts of Ramps A and D are bridges. The at-grade sections of Departures Drive are concrete pavement sections.

As with the Arrivals Drive Roadway, the at-grade Ramps were built as part of the Access Roadways Phase II project.

The portions of Ramps A and D which were built on grade show similar deterioration to Arrivals Drive. This includes wide-spread deterioration of pavement and curbs, as well as signs which are non-reflective and/or obstructed as illustrated in **Figure 11.2-31**.

Figure 11.2-31: Pavement and shoulder deterioration typical of Ramps A and D approaches

Source: EDSI, 2021.

Recommendations

- Refer to Effective Remaining Useful Life Section.

Departures Drive Bridges

The Departures Drive Bridges consist of four bridges. The main bridge is a passenger drop-off area adjacent to Terminal 1. Additionally, there are two ramp bridges (Ramps A and D), which carry traffic to the passenger drop-off area from westbound LIB and Airflight Drive, respectively, and a bridge at the west end of Departures Drive which carries Departures Drive over Arrivals Drive.

DEPARTURES DRIVE BRIDGE

The original bridge, built around 1965, consists of a 12” thick flat concrete slab with drop panels at column locations. The east end of the bridge, where the structure curves to meet Ramps A and D, is shown as a

voided slab superstructure on the original construction drawings. The most recent significant renovations appear to have been completed in the late 1990s (Letting Number 7959). These renovations resulted in a variable thickness driving surface, asphalt on the south side of the structure and concrete (apparently unreinforced) on the north side of the structure. An existing concrete surfacing layer is located under the variable thickness driving surface. A layer of unknown composition is located below the existing concrete surfacing layer and above the structural slab. Several localized joint replacement projects have been completed after the driving surface replacement. The existing wearing surface, in the areas surfaced with both concrete and asphalt, is showing significant deterioration, primarily near joints and drains, as shown in **Figure 11.2-32**. The deterioration results in water infiltration into the structure, potentially causing further deterioration. The underside of the superstructure and the substructure are not accessible for visual assessment. Indications of the structural condition and potential deterioration or damage to the inaccessible portions of the structure are not verifiable.

Figure 11.2-32: Departures Drive showing deteriorated driving surface

Source: EDSI, 2021.

The westernmost support for the Departures Drive Bridge, as well as one of the substructure units for the Departures Drive Bridge over Arrivals Drive, is concealed behind precast fascia panels. Construction drawings for these fascia panels are not available. Some of the panel joints between the panels exhibit deteriorated joint material and open areas and there are areas of localized deterioration mainly due to water damage. The enclosed area inside the fascia panels exhibits a significant amount of water infiltration/leakage resulting in substructure deterioration.

Recommendations

- Refer to Effective Remaining Useful Life Section.

RAMP A AND RAMP D BRIDGES

The Ramp A and Ramp D Bridges were constructed as part of the Access Roadways Phase II project (Airport Letting Number 7586) in the late 1980s. Both bridges are steel curved girder bridges with composite reinforced concrete decks. The substructures consist of non-integral reinforced concrete bents supported on steel H-Piles. The ramp bridges converge and abut the Departures Drive Bridge and Terminal 1 (Building) at the eastern end of Departures Drive.

The ramp bridges are in generally good condition. Paint on the bottom flanges of the steel girders, as shown in **Figure 11.2-33**, is starting to deteriorate and bubble, indicating potential corrosion of the steel. The corrosion of the intermediate diaphragm connector plates and flange splice plates is more advanced. Bird droppings are present and could potentially accelerate corrosion. The joints at the ends of the ramp bridges are allowing water leakage which is causing rust to develop at the ends of the girders. At least one deck drain appears to be clogged and the deck drain piping is corroded at a minimum of one location. Joint and deck drain cleaning and/or replacement are considered to be regular general maintenance items that should be performed on a periodic basis and are not included in ALP budgeting.

Figure 11.2-33: Bottom of Ramp D girders showing deterioration of paint

Source: EDSI, 2021.

Recommendations

- Refer to Effective Remaining Useful Life Section.

DEPARTURES DRIVE OVER ARRIVALS DRIVE BRIDGE

Based on information in the Draft Bridge Inspection Report, provided by STLAA and dated July 23, 2020, this bridge was built in 1970 (at the same time as the parking garage). No construction plans for the bridge are available. The bridge is a two-span structure and site observation and Bridge Inspection Report information indicate that the bridge superstructure is comprised of conventionally-reinforced cast-in-place concrete girders and deck, including asphalt overlay, with an unusual framing plan to accommodate the roadway geometrics. The northeastern pier is hidden by precast fascia panels, and the superstructure cantilevers past the pier (visual observation). The intermediate bent is supported on columns (foundation type unknown), and the southwestern abutment appears to be one of the walls of the garage structure. The joints at both ends of the bridge have been recently replaced.

The superstructure of this bridge is showing serious deterioration at multiple locations. The ends of the cantilevered beams on the northeastern end of the bridge (visible from within the area enclosed by the precast fascia panels) exhibit significant exposed steel reinforcement. Water leaking through the joint area at the departures drive level between the Departures Drive Bridge and the bridge superstructure is a significant contributor to beam deterioration. The end diaphragm beam at the southwestern abutment shows significant spalling and exposed, and in some cases broken, steel reinforcement (rebar) as illustrated in **Figure 11.2-34** and **Figure 11.2-35**. In addition, the steel roller bearings are significantly corroded and may not be functioning as designed. Spalling of concrete and exposed rebar on the underside and edges of the deck in multiple locations are also significant. Multiple deteriorated areas of the deck concrete with spalling and/or exposed rebar are visible, along with indications that other areas of the deck have been previously patched. The pedestrian fence appears to be rusting where the fence is embedded in the barrier curb, and the rust has caused the concrete to break apart and spall off at these locations. The bridge has a posted clearance of 11'-0" and has been hit repeatedly by over-height vehicles on Arrivals Drive, as indicated by numerous scrapes on the bottom sides of the girders. The beams also exhibit cracking with some efflorescence (noted in 2020 Draft Bridge Inspection Report). The water leakage issue and the bearings at the southwestern abutment should be evaluated and repaired and/or replaced as part of general maintenance activities. Safety enhancements should also be considered as part of general maintenance activities, including the addition of barriers at the base of the intermediate bent columns.

Figure 11.2-34: Departures Drive over Arrivals Drive Bridge southwest end beam showing deteriorated concrete, exposed rebar, and rusted bearings

Source: EDSI, 2021.

Figure 11.2-35: Departures Drive over Arrivals Drive Bridge – Deteriorated beam ends and water leakage within area enclosed by fascia panels

SOURCE: EDSI, 2021.

TERMINAL 2

Arrivals Drive Roadway

The Arrivals Drive Roadway was built with Terminal 2 in the late 1990s. The intersection of LIB and Air Cargo Drive/Terminal 2 Arrivals Drive has been reconfigured several times. Currently, a project is under

construction to add Arrivals Drive capacity north of the main through lane of Arrivals Drive at the southeast corner of Terminal 2.

Figure 11.2-36: Non-reflective signage and worn pavement markings on Arrivals Drive

Source: EDSI, 2021.

The Arrivals Drive Roadway consists of a concrete pavement section which is in generally good condition. The curbs are scuffed/damaged in a few places. The salt spray guard pavers exhibit settlement in several locations which has created a small step between the pavers and the curb. The pavement markings, both roadway striping and crosswalks, are fading in several locations as well as shown in **Figure 11.2-36**.

Recommendations

- Refer to Effective Remaining Useful Life Section.

Departures Drive Roadway

The Departures Drive Roadway was built with Terminal 2 with construction completed in 1998. It consists of a concrete pavement section. Most of Departures Drive is a bridge (refer to the following section). The traffic patterns for dropping off passengers, as directed by the striping, were changed in early 2020 to help the traveling public use the drop-off area more efficiently, lowering the likelihood that vehicles would queue down the ramp of Departures Drive onto Air Cargo Road.

The Departures Drive Roadway is in generally good condition. Isolated pavement cracking and some damaged curbs are present on the approaches to the bridge.

Recommendations

- Refer to Effective Remaining Useful Life Section.

Departures Drive Bridge

The Departures Drive Bridge was built with Terminal 2 in the late 1990s. The bridge consists of several single and multiple span units. Each unit is comprised of a multiple girder/reinforced concrete deck superstructure. The approach span units are comprised of steel girders, and the main spans are comprised of prestressed concrete girders. All substructure units (end and intermediate bents) are cast-in-place concrete and are probably supported on piles. Depending on the roadway geometrics, spans are horizontally tangent, curved, or flared. The western abutment is assumed to be supported on piles, with the roadway embankment retained by a mechanically stabilized earth (MSE) wall. The Terminal 2 Arrivals Drive/passenger pickup area and entrance to the parking garage are under the bridge.

The Departures Drive Bridge is in generally good condition. The Draft Bridge Inspection Report, provided for this bridge by STLAA and dated July 23, 2020, is consistent with the visual assessment observations. **Figure 11.2-37** shows girder ends exhibiting minor rusting at the east abutment and isolated rusting of intermediate diaphragm connector plates. Streaks of rust on end diaphragms are visible under the joints and indicate water leakage through the joints, which may or may not be an active process. The joints were replaced recently (Project Number EA15-028, ca. 2015), so the rust staining may have occurred prior to the joint replacement project. The deck of the bridge exhibits minor ponding of rainfall. The Draft Bridge Inspection Report indicates some cracking of the MSE wall cap at the western abutment.

Figure 11.2-37: Rusted intermediate diaphragm connector plate on Departures Drive Bridge

Source: EDSI, 2021.

Recommendations

- Refer to Effective Remaining Useful Life Section.

LAMBERT INTERNATIONAL BOULEVARD (LIB)

Lambert International Boulevard (LIB) was built as part of the Access Roads project, which replaced the previous access road configuration and consisted of three phases built from the early 1980s to the early 1990s. Phase I included the easternmost segment of LIB, from the I-70 W off-ramp to partway along Terminal 1 Concourse D, where westbound traffic splits to proceed to Terminal 1 or the garage and I-70 W. Phase II, the middle section, included LIB from the western end of Phase I construction to the west end of the Terminal 1 parking garage, between the intersections of LIB with Terminal 1 Departures Drive and Terminal 1 Arrivals Drive. Phase IIIA included LIB from approximately what is now known as Airfield Service Lane at the east end to the Cypress Road intersection at the west end, and Phase IIIB with limits from the western end of the Terminal 1 parking garage to approximately Airfield Service Lane. The LIB Bridge over Airflight Drive predated the Access Roads project but was modified as part of Phase II. The modifications seemingly were joint replacements/general rehabilitation. The Access Roads Project Phase IIIA included construction of the LIB Bridge over Coldwater Creek (See additional commentary in Section 11.6.2,

Roadways and Bridges). For more information specific to LIB bridges, see the following sections. In addition to the original construction, LIB appears to have had multiple rehabilitation efforts completed over the years, including replacement of concrete slabs and patching as illustrated in **Figure 11.2-38**.

The scope of visual assessment for this project included LIB from Cypress Road at the west end to just east of the intersection at which vehicles can enter Terminal 2. LIB consists of both concrete and asphalt pavement sections, with the majority comprised of concrete pavement sections. The concrete pavement exhibits cracking in some areas along with curb and joint deterioration. Several structural overhead signs are located along LIB, with most of the signs exhibiting some level of deterioration of either the base, post, or both. Street lighting is present and is in generally satisfactory condition with some minor deterioration evident. Nine signalized intersections are present along LIB that are generally in satisfactory condition, however, some deterioration is present to the heads, posts, bases, and mast arms. Some drainage structures exhibit damaged tops. Drainage patterns were not discernable during the site visit to determine if issues pertaining to ponding are present.

Figure 11.2-38: LIB showing typical pavement patching and worn curbs

Source: EDSI, 2021.

Recommendations

- Refer to Effective Remaining Useful Life Section.

LIB Over Airflight Drive Bridge

The LIB Bridge over Airflight Drive was built in the late 1960s. The bridge is a three-span voided slab bridge with non-integral bents (based on plans developed during two successive rehabilitations of this bridge). During the most recent rehabilitation (circa 2015, Letting Number 8563, BRO-B 115-15 Part A), the original roller bearings were replaced with elastomeric bearing pads. The concrete walls and the joints, both longitudinal and transverse, have been repaired/replaced several times.

The LIB over Airflight Drive Bridge is in generally good condition, except for a few spalls on the bottom of the slab near the bearings on the south side of the west abutment. The spalls may be caused by water leaking through the joint, although evidence during the visual assessment was not conclusive. The retaining walls supporting the roadway embankments, however, are in poor condition as shown in **Figure 11.2-39**. Most of the vertical construction joints are seriously degraded, as is the wall cap/roadway barrier. Pieces of concrete which have broken away from the wall are on the sidewalk.

Figure 11.2-39: LIB over Airflight Drive Bridge approach retaining wall joint and barrier curb showing significant deterioration

Source: EDSI, 2021.

Recommendations

- Refer to Effective Remaining Useful Life Section.

LIB to Terminal 1 Garage Bridge

The LIB to Terminal 1 Garage Bridge illustrated in **Figure 11.2-40**, which is adjacent to and abuts the LIB Bridge over Airflight Drive, carries traffic from LIB into the top (brown) level of the Terminal 1 parking garage. This bridge was presumably built at the same time as the parking garage. The bridge is a two-span structure with a flat slab span adjacent to LIB and a cast-in-place concrete girder span adjacent to the parking garage. The two end bents and the intermediate bent are on columns with unknown foundations.

Figure 11.2-40: Underside of LIB to Terminal 1 Garage Bridge superstructure

Source: EDSI, 2021.

This bridge, because of its proximity to the LIB over Airflight Drive Bridge, is typically rehabilitated together with the LIB over Airflight Drive Bridge. The joints on this bridge were replaced recently and an overlay was applied at the same time as the recent rehabilitation of the LIB Bridge over Airflight Drive. No significant deterioration is evident.

Recommendations

- Refer to Effective Remaining Useful Life Section.

Airflight Drive

Airflight Drive was reconstructed in the late 1980s as part of the Access Roadways Project Phase II. Airflight Drive provides the main access to Terminal 1 from south of I-70 as well as access to the airport-focused businesses and several municipalities south of I-70. The Airflight Drive interchange is the responsibility of MoDOT. The Airport owns the portion located north of the north interchange traffic signal.

The Airflight Drive pavement is in generally good condition. The curbs and islands exhibit general deterioration due to age. As in other locations, the pavers located behind the curb, originally intended as salt spray protection, exhibit settlement. Soil is accumulating on top of the settled pavers and is being retained by the curb.

Recommendations

- Refer to Effective Remaining Useful Life Section.

ROADS AND BRIDGES SUMMARY

Based on the outlined assessments for the Roadways and Bridges, the Remaining Useful Life is summarized in the following section for each component. Refer to Appendix 11B for the condition assessment values.

For the overall evaluation of each component, the Remaining Useful Life and Condition Assessment values reflect the worst case of either the roadways or bridges, assuming that the entire component will be reconstructed at the same time.

The evaluation of the small part of Airflight Drive that was assessed is included with the calculations for the Terminal 1 Roadway segments, both arrivals and departures.

Recommendations

- Refer to Effective Remaining Useful Life Section.

Effective Remaining Useful Life

TERMINAL 1 ROADS

The at-grade roads servicing Terminal 1 were originally constructed in the early 1970's and reconstructed in the late 1980's as part of Access Roadways Phase II project. Minor repairs and rehabilitations have been completed in the subsequent years. The reconstructed roadway system is approaching 35 years of service life. The curbing for the roadway pavement shows the most deterioration with sections of roadway exhibiting both cracking and joint deterioration. A few pavement areas do not drain properly, resulting in ponding of

rainwater. In addition to the safety concerns this condition raises, improper drainage and ponding accelerate the deterioration of the pavement sections as water infiltrates cracks and migrates into the subbase of the pavement section.

The remaining useful life for the Terminal 1 Roadways (both Arrivals and Departures) is estimated to be five to six years. The maintenance will be excessive if major rehabilitation is not performed.

Recommendations

- Replacement of the Terminal 1 Roads should occur within five years, concurrently with the Replacement of Terminal 1 Bridges.

TERMINAL 1 BRIDGES

In the 2008 visual inspection and load rating analysis report of Arrivals Drive (then known as Baggage Claim Drive), the Arrivals Drive Bridge was estimated to have a remaining service life of 10 years. Although significant work has been completed on the Arrivals Drive Bridge in the intervening decade, water leakage is an ongoing problem. The water leakage is located primarily at the joints. Additionally, the load rating calculated in the 2010 load rating analysis listed a maximum Gross Vehicle Weight of 13 tons and a maximum single axle weight of 10.4 tons, with a posted speed limit of 10 miles per hour. These limitations restrict the size/weight of shuttle buses that serve the airport and increase shuttle bus travel time duration. The remaining useful life for the Arrivals Drive Bridge is estimated to be less than five years.

In the 2008 visual inspection and load rating analysis report for Departures Drive (then known as Ticketing Drive), the main Departures Drive Bridge was estimated to have approximately 15 years of remaining service life, provided that the repairs recommended in that report were made and the structure was properly maintained. The immediate recommended repairs focused on decreasing the amount of water intrusion into the structure. Water intrusion is still a concern because of the seriously deteriorated driving surface. The remaining useful life for the Departures Drive Bridge is estimated to be less than five years.

The Departures Drive over Arrivals Drive Bridge has a similar remaining useful life of at most five years. This estimate is based on significant visible deterioration. Additionally, the vertical under-clearance is substandard and the bridge is periodically hit by vehicles traveling on Arrivals Drive. The vehicle impacts not only cause damage to the beams but also indicate that this bridge is functionally obsolete.

The Ramp A and D Bridges are in overall good condition. However, depending on the scope and details of replacement of the other Departures Drive Bridges, the Ramp A and D Bridges may need to be replaced or significantly changed to allow for the new construction, including any potential geometric revisions which might be developed.

Recommendations

- Replacement of the Terminal 1 Bridges should occur within five years.

TERMINAL 2 ROADS

The at-grade roads servicing Terminal 2 were originally constructed in the late 1990's. Some minor repairs to the roadway system have been made. The at-grade roads exhibit some minor cracking and joint deterioration. In addition, a small portion of the curbs exhibit damage. Other deficiencies are present, such as faded pavement markings and signs. The remaining useful life for the Terminal 2 Roads is estimated to be ten to twelve years.

Recommendations

- Replacement of Terminal 2 Roads should occur within approximately ten to twelve years. Some minor rehabilitation of selective pavement and associated items could be considered within a two-to-five-year timeframe to extend the life of the Terminal 2 Roads to the programmed replacement year.

TERMINAL 2 BRIDGE

The Terminal 2 Departures Drive Bridge, built in 1998, is in very good condition. The bridge is typical of bridges built in the late 1990s, which can be expected to last upwards of 50 years with appropriate maintenance activities. Based on the age of the bridge (22 years) and the visually observed condition, the Departures Drive Bridge is estimated to have more than 20 years of remaining useful life.

Recommendations

- Replacement of the Terminal 2 Bridge should be coordinated with the Replacement of the Terminal 2 Roads as outlined in the preceding paragraph. Some minor rehabilitation measures could be considered within a two-to-five-year timeframe.

LAMBERT INTERNATIONAL BOULEVARD (LIB) ROADS

LIB was built as part of the Access Roads project (Phases I, II and III) from the early 1980s to the early 1990s. The project included completely new pavement, base, storm sewers, signing, striping and signals.

The concrete pavement sections of LIB exhibit a larger degree of deterioration than the asphalt pavement section located near the Terminal 1 Garage. Due to the length of this roadway segment (approximately 2 miles), and the fact that construction and major reconstruction activities have taken place over a period of time, the following observed deficiencies are not uniformly spread over the entire length of the roadway. The concrete pavement shows signs of cracking, curb damage, and joint deterioration. Twenty-three (23) overhead structural signs are located within the evaluated section of LIB. In general, these signs are in satisfactory condition, but some signs exhibit deterioration. Nine signalized intersections are located along LIB and are in generally satisfactory condition, but also show signs of some damage and deterioration.

The roadway sections most in need of major repairs were considered as the driving factor in determining the remaining useful life of the entire segment. The remaining useful life for LIB is estimated to be about 10 years.

Recommendations

- Replacement of the LIB Roads should occur within ten years.

LIB BRIDGES

The LIB Bridge over Airflight Drive is approximately 50 years old. If the spalls on the underside of the superstructure slab are repaired, the remaining useful life of this bridge should exceed 5 years and may exceed 10 years, with appropriate maintenance, including, but not limited to, periodic replacement of the joints and associated retaining wall rehabilitation work.

The LIB to Terminal 1 Garage Top Level Bridge has recently been rehabilitated and does not show any indications of significant deterioration. The remaining useful life of this bridge is estimated to exceed 5 years. However, if significant work is undertaken on either the upper level of the Terminal 1 Garage or the LIB Bridge over Airflight Drive, the LIB to Terminal 1 Garage Top Level Bridge will most likely have to be replaced to maintain compatibility.

The LIB over Coldwater Creek Bridge is currently in the design process for rehabilitation. Based on the current rehabilitation scope, the anticipated remaining useful life of this bridge exceeds 10 years. (See qualifications and limitations section for this bridge.)

Recommendations

- Replace the LIB Bridge over Airflight Drive, concurrent with the replacement of LIB Roads within 10 years. Replace the Terminal 1 Garage Top Level Bridge concurrent with the replacement of LIB Roads and/or with the replacement of the Terminal 1 Garage.

Facility Condition

Table 11.2-1 summarizes the facility condition of the roadways and bridges at each terminal as well as at LIB.

Table 11.2-1: Roads and Bridges Condition Summary

COMPONENT SYSTEM	COMPONENT SUB-SYSTEM	CONDITION ASSESSMENT	EST. RUL	PRIORITY
T1		**2**	**< 5**	
	Roads	2	6	2
	Bridges	2	< 5	1
T2		**3**	**12**	
	Roads	3	12	2
	Bridge	4	>20	3
LIB		**3**	**>5**	
	Roads	3	<10	2
	Bridges[1]	3	>5	2

Notes:

[1] LIB over Coldwater Creek Bridge is not included.

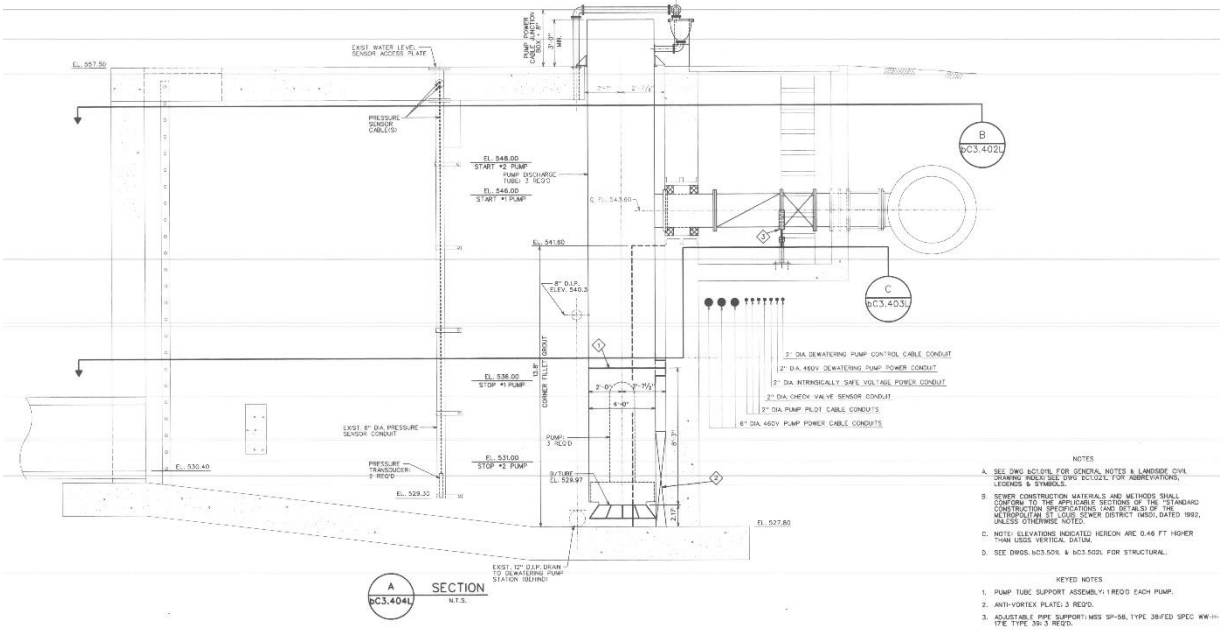
Source: EDSI, December 2020.

STORMWATER PUMPS

The stormwater pump station is located outside of Terminal 2 adjacent to the Terminal 2 (T2) loading dock. The purpose of the stormwater pump station is to convey stormwater to prevent flooding in the lower level of the T2 parking garage when the horseshoe storm culvert under I-70, the outer road, T2 garage, and T2 terminal becomes overcharged. **Figure 11.2-41** provides a section view of the pump station. The exterior portions of the pump station were inspected on June 22, 2020. No confined space entry was possible on June 22, 2020 since the wet well vault cover is bolted and the dewatering pump hatch is not operational. Maintenance is performed on the pump station by a contracted maintenance service provider.

The assessment of the components of the pump station are based on information provided by Airport Subject Matter Experts and the maintenance service provider for the pump station as well as visual inspection of above grade piping, pump housings, vault covers and hatches, and electrical conduit.

Figure 11.2-41: Pump Station Section View



Source: M3 Engineering, 2021.

The primary stormwater pumps are 22 years old and only have 3.5 hours of run time over the 22-year life. The limited amount of pump run times are assumed to be maintenance run time, though technical experts for the Airport state the pump station operated to prevent flooding during a storm event following the pump station coming online.

One pump is sent to the manufacturer for inspection and repair every year, so that each pump is serviced by the manufacturer every 3 years. These pumps, as shown in **Figure 11.2-42**, are in good condition based on the low amount of run time, limited visible wear on impellers, and that each pump receives annual maintenance. The remaining useful life of these pumps is greater than 10 years.

The remaining useful life of the dewatering pump is 1-5 years based on information provided that the pump is 22 years old and needed to be rebuilt in 2010. A spare pump is stored on site.

Figure 11.2-42: Primary Stormwater Pumps and Impeller (Per Previous Inspection by Others)

Source: M3 Engineering, 2021.

The above grade pump housings and piping are experiencing corrosion and will require sandblasting and recoating to maximize the life of these components. The pump housing gaskets, illustrated in **Figure 11.2-43**, require replacement. The maintenance service provider for the pump station stated valves were operational with no sticking.

Figure 11.2-43: Example of a Primary Stormwater Pump Housing and Valve

Source: M3 Engineering, 2021.

The control panels and above grade electrical controls system conduits shown in **Figure 11.2-44** are in good condition. Electrical connections and amp draw are being checked every year.

Figure 11.2-44: Electrical Conduit and Control Panels

Source: M3 Engineering, 2021.

A summary of the major components of the stormwater pump station and associated condition evaluation is shown in **Table 11.2-2**:

Table 11.2-2: Stormwater Pump Station Component Evaluation Summary

COMPONENT	MAKE/MODEL	QUANTITY	DESCRIPTION	EVALUATION
Primary Stormwater Pumps	Flygt Model C3531	3	The pumps are 22 years old with 3.5 hours of run time over the 22-year life and receive regular maintenance.	Good
Dewatering Pump	Flygt	1	The dewatering pump is 22 years old and was rebuilt in 2010, so it is anticipated to need to be rebuilt or replaced in 1 to 5 years. A spare pump is available on site.	Fair
Piping	N/A	N/A	Corrosion is visible on above grade piping and in need of sandblasting and recoating	Fair
Valves	N/A	8	Minor corrosion visible on above grade valves. Maintenance service contractor noted valves are	Fair

COMPONENT	MAKE/MODEL	QUANTITY	DESCRIPTION	EVALUATION
			operational and not sticking. Condition primarily based on age.	
Electrical Panels	N/A	3	Electrical Panel enclosures are stainless steel and in excellent condition but were not able to be opened for further inspection.	Good
Electrical Conduit	N/A	N/A	No signs of defects with above grade electrical conduit systems	Good
Instrumentation & Controls	N/A	3	Pump control sensors and control systems are in good condition per the maintenance service provider.	Good
Pump Housings	N/A	3	Pump Housings are corroding and in need of sandblasting and recoating	Fair
Wet Well & Valve Vault Structure	N/A	1	The condition of below grade structures was not assessed during the inspection, but the maintenance service provider rated the condition as excellent noting no cracks in concrete.	Excellent

11.3 Opinions of Probable Costs

Opinions of probable cost were prepared to remedy physical deficiencies for items that were observed or reported and were distinct and quantifiable, and for items that are expected to be required in the future based on the age or condition of assets. Cost estimates are based on the estimated cost to bring those items identified up to a sustainable condition, but not necessarily to a like-new condition. General costs for ongoing maintenance are not estimated.

Similar to condition assessments, cost estimates are based on requirements for facilities to meet their current use, and not for any planned future use. Costs are not calculated to renovate unoccupied areas to accommodate a new function. The cost of renovations to change the use of areas that are currently unoccupied should be included in planning estimates based on the planned future use of that space.

Repair and replacement costs include allowances for ancillary modifications and repairs that would be required to implement the recommended repair or replacement. As an example, HVAC repairs might include the cost of ceilings to replace those removed to accommodate the HVAC repair. As such, the sum

of estimated repair costs might exceed the estimated cost to reconstruct a particular building component or an entire building.

All estimates are prepared on the basis of 2020 dollars. Escalation at the rate of 3 percent per year are added to the project cost allocation in future forecast periods of 1 yr., 2 – 5 yrs., 5 – 10 yrs., and 10 – 15 yrs. Estimates are calculated as a Contractor price that includes a project specific adjustment for productivity for work within the airport or secure areas and a project specific design contingency. Estimated project costs include markups added to the contractor price for General Contractor's overhead, bonds, insurance and profit; architect/engineering fees; soft costs; and construction contingency.

A summary of engineers' estimates of the costs to complete recommended repairs, is included in Appendix 11C.1.

11.4 Additional Considerations

This report focuses on the condition of existing terminal, concourse and central utility infrastructure to reliably support the functions for which the facilities were constructed. The disposition of any such current infrastructure may affect the performance of other airport facilities or operations and therefore may impact future long-range planning for the airport. Where such potential ancillary impacts were foreseen, they were documented here for consideration in future airport planning.

11.4.1 Code Compliance

The various Airport facilities were designed in compliance with codes and standards that were in force at the time the respective facilities were constructed or most recently renovated. At such time as any area of the Airport facilities are renovated, those facilities must be brought into compliance with current building codes. The airport is generally in compliance with ADA, but some areas have not been brought into compliance and some areas may not comply with newer provisions of the Act.

Preliminary review suggests that new construction and major renovations will require automatic fire suppression throughout, and existing water supplies are provided to accommodate the limited fire suppression typical throughout the airport. Due to the increased combustibility of automobiles, code authorities are also considering requiring sprinklers throughout parking garages. Water supplies to the airport would be inadequate to support fire sprinklers throughout the terminal and concourses or to provide sprinklers in existing or new parking structures.

Existing facilities do not meet current energy codes. While energy code compliance will reduce impacts on existing utilities, some infrastructure such as plumbing water supplies and drainage, fire suppression water supplies HVAC ventilation, or electrical power supplies, may require extensive upgrades back to their utility connections to be brought into full code compliance.

11.4.2 Climate Control

Steam and chilled water supply from the two Climate Control Plants (CCW and CCE) provide heating and cooling for T1, T2, A, B, C, D, and E, as well as to other buildings on the airport such as the Airport Office Building (AOB), Airport Rescue and Fire Fighting (ARFF) stations, the airfield maintenance facility and the airport shops. Utility support to these ancillary buildings needs to be considered in future plans impacting either central utility plant.

Steam and chilled water supply from CCW serve as a partial standby heating and cooling supply for CCE, and vice-versa. Switchover to allow areas served by either plant to be supplied by the other plant requires manual modifications to valve positions, but piping is in place to allow either plant to supply steam and chilled water to airport facilities normally conditioned by the other plant. Without either central plant no back-up capacity exists for the remaining plant.

CCE is integral to concourse D/E located on the apron level of Concourse E between gates E33 and E34 (Column lines 194-204) at the elbow between Concourse D and the E connector. Reconfiguration of the east end of Concourse D or the west end of Concourse E needs to consider the impact to CCE and the functions provided by that central plant.

11.4.3 Utility Tunnels

Tunnels under the terminals and concourses carry service utilities such as main electrical power feeders, communication wiring, domestic and fire protection water supplies, steam and chilled water to heat and cool the buildings, and condensate return piping from the condensed steam, from the two Climate Control facilities to their points of use. These tunnels and the services inside them are critical to the functionality of the terminals and concourses. For any one of the terminals or concourses to remain in service, the tunnels need to remain in-tact or alternative services need to be provided. If any terminal or concourse is taken out of service, or demolished, the utility tunnel and services underneath may need to remain in service.

11.4.4 Displacement of Infrastructure Services

Some utilities such as security, IT, climate control, etc. are centrally located in the Climate Control facilities serving the terminal and concourses or within IT rooms in the terminal and concourses, but those utilities may serve buildings around the airport that may be remote from the terminal. Reconfiguration of the terminal or concourses needs to take into consideration utility services that may be displaced.

11.4.5 Roadways and Bridges

Replacement of either the departures or arrivals roadways and bridges is assumed to occur at the same time and the Condition Assessment and Estimated Remaining Useful Life for each Component System is controlled by the most critical value of either the roadways or bridge(s).

Replacement of the Terminal 1 Bridges will require replacement of interior finishes which comprise baggage handling and office areas, as illustrated in **Figure 11.4-1** below. Replacement of Terminal 1 Bridges will also affect portions of the Terminal 1 Parking Garage.

Figure 11.4-1: Areas with Interior Finishes

Source: WSP USA, 2021.

11.5 Physical Supplemental Testing

11.5.1 Structural Assessment of Concourse D Foundation Walls

A supplemental foundation survey on Concourse D was undertaken to investigate observed distress to the exterior concrete foundation walls. During the initial site visits for the FCA, fracturing and inward leaning of the foundation wall that supports the exterior CMU masonry was observed in mechanical room D1126. It was also noted during the SME interviews that there was concern for building movement at Concourse D from building maintenance staff. Further information was received stating that similar distress can be seen at the Concourse E extension between gates E29 and E33.

The FCA Team performed an in-depth evaluation of the foundation at Concourse D. The evaluation included visual evaluation of the interior and exterior of Concourse D, mapping of distress to the foundation, and plumbness measurements of the concrete walls and columns. The evaluation extended from column #101 to column #214.

WSP analyzed the data collected and correlated it with the mapped distress. The supplemental investigation indicates that there is no movement of the superstructure at Concourse D. The investigation shows that there is localized movement of shallow bearing foundation walls at three mechanical rooms along the apron level of Concourse D. See the supplemental structural assessment report included in Appendix 11F for full observations, extent of the distress to the shallow bearing foundation walls, and the recommendations for repairs.

11.5.2 Fire Sprinkler Pipe Testing

Ultrasonic shearwave testing was performed in select locations on fire sprinkler piping, and chemical analysis was performed on water samples from the fire sprinkler system. The ultrasonic testing was to assess the progression of corrosion discovered inside the sprinkler piping during testing performed in 2014 and 2015. Water samples were tested to detect conditions that could contribute to corrosion in the piping system.

Ultrasonic testing performed in 2015 indicated the presence of grooving corrosion in main sprinkler piping on most areas of the terminal and concourse tunnels, but no corrosion was found in Concourse E. The recent testing demonstrates expansion of the corrosion previously detected with confirmed corrosion in Concourse E, and corrosion in some other locations that previously showed no corrosion.

Ultrasonic testing was performed on fire protection sprinkler piping Briem Engineering to evaluate the condition of fire protection piping since testing was last performed in December 2015. Ultrasonic inspections were performed on piping that did not have ultrasonic indications of corrosion in the 2015 inspection. Visual inspections were performed on piping that did have ultrasonic indications for corrosion in the 2015 inspection.

The ultrasonic test results indicate that new piping corrosion has occurred where corrosion had not previously occurred in the same locations that were tested 5 years ago.

- No expansion of corrosion was demonstrated by testing in Concourse A, B or C, but pipe leakage observed in Concourse A indicates further deterioration of piping that had corrosion in 2015.
- Some expansion of corrosion was demonstrated by testing in Terminal 1, and pipe leakage observed in Terminal 1 indicates further deterioration of piping that had corrosion in 2015.
- Expansion of corrosion was demonstrated by testing in the east end of Concourse D.
- Expansion of corrosion was demonstrated by testing throughout Concourse E which did not exhibit corrosion in 2015. Pipe leakage was also observed in Concourse E.

The water sample lab analysis identified the presence of magnetic deposit material in all the samples indicating that corrosion is actively occurring and identified conditions that permit scaling where deposits can form on the inside of the pipes. The report identifies under deposit corrosion as the leading cause of pinhole leaks within fire protection systems.

The report for the ultrasonic testing of sprinkler piping and water sampling is included in Appendix 11G.

11.5.3 Dry Type Transformer Testing

WSP coordinated testing of selected transformers that have been in service at the airport for 30 years or more to identify any faults in the transformer wiring or degradation of insulation in aging transformers across the facility. The tests performed by Aschinger Electric with support from the Airport Electric Shop include:

- Windings ratio test, to identify possible shorted windings in the transformer
- Insulation resistance test, to verify the integrity of the transformers insulation which can break down over time or due to environmental conditions.

Free standing low voltage transformers, and some transformers integral to unit substations were tested to inform the airport about the condition of older transformers and allow the airport to make proactive decisions relating to the possible replacement of any transformers found to have deficiencies which may lead to a future failure, and to avoid unexpected transformer failures.

Nine transformers were tested in different locations around the airport. Electricians locked out & tagged each transformer, the cover was removed, feeders were disconnected from the transformer primary & secondary, and testing was performed. Transformer interiors were cleaned, feeders were re-connected, and lugs tightened to specified torque. For all transformers tested, the test results were within acceptable performance parameters and no problems were identified.

The report for the dry type transformer testing is included in Appendix 11H.

11.6 Qualifications and Limitations

11.6.1 Out of Scope Considerations

Remote Airport Buildings: Airport facilities beyond the limits of the terminals, concourses, and central utility plants, such as the Airport Office Building (AOB), Airport Rescue and Fire Fighting (ARFF) stations, airfield maintenance facility and airport shops, hangers and cargo facilities, and FAA offices and control tower were excluded.

Movable Furnishings: This Facility Condition Assessment (FCA) report focuses on the condition of existing terminal, concourse and central utility infrastructure to reliably support the functions for which the facilities were constructed. As such, the FCA looked at built-in component and infrastructure of the subject facilities.

The FCA did include airport furnished infrastructure and utilities supporting tenant spaces but did not include assessment of any movable furnishings or equipment, or tenant owned improvements and equipment. The FCA did not include any airline owned gate equipment including passenger boarding bridges, or ramp equipment such as PC Air 400 Hz power supplies, and glycol handling systems. The FCA also did not include any TSA or CBP screening equipment.

Code Compliance: The FCA did not include a general assessment of code compliance. Code compliance was considered for some items in relationship to repair and replacement costs, and code compliance may be mentioned as it relates to such items.

11.6.2 Roadways and Bridges

The roadways and bridges were assessed based on visually accessible components and available existing information. The visual assessments are based on the visual observations made on the date and at the time of the field visits. An in-depth inspection of existing conditions and/or testing was not performed. This includes any analysis of the existing drainage system or signal phasing. The Terminal 1 Bridges include significant areas that are not accessible, as shown in **Figure 11.6-1**. Existing available information includes some construction plans, rehabilitation plans, and inspection/condition reports. A complete archive of plans and reports was not available.

Lambert International Boulevard (LIB) over Coldwater Creek Bridge, built as part of the Access Roads Phase III project in 1992, was not part of the scope of visual assessment under this Facility Condition Assessment project. Rehabilitation designs for this bridge are currently being developed under a separate contract. The anticipated scope of work includes encasing pile bents at intermediate piers, adding a sidewalk pedestrian bridge on north side, rehabilitating the deck with an epoxy polymer overlay, and replacing both approach slabs and a portion of concrete pavement.

Figure 11.6-1: Terminal 1 Bridges – Inaccessible Areas

Source: EDSI, 2021.