

AUDIT REPORT

Denver International Airport

Airside Construction Projects

July 2017

**Office of the Auditor
Audit Services Division
City and County of Denver**



**Timothy M. O'Brien, CPA
Denver Auditor**



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July 20, 2017

AUDITOR'S REPORT

We have completed an audit of airside construction projects at Denver International Airport (DEN), managed by the Airport Infrastructure Management (AIM) Division. Airside construction projects constitute the initial building or subsequent repair of areas accessible to aircraft at an airport, including roadways, runways, apron pavement, and taxiways. The objective of the audit was to determine whether DEN's AIM Division has effective controls in place to ensure that airside construction projects are managed appropriately and address fraud, waste, and abuse. In addition, we determined whether construction projects are following various rules and regulations. We also reviewed AIM's internal controls surrounding the timekeeping process of staff augmentation contractors.

As described in the attached report, our audit revealed that the AIM Division needs to develop stronger internal controls surrounding the review and approval of airside technical specifications and document management practices, as well as evaluate the efficiency and effectiveness of its multiple project management computer systems. We also found that DEN's Business Management Services Division (BMS) needs to improve its internal controls surrounding the construction bidding process.

Through stronger project management controls and monitoring, the AIM Division will be able to improve its project management and strengthen the controls already in place. Likewise, through stronger controls over the construction bidding process, BMS will be better positioned to maintain the integrity of the bid process. Our report includes seven related recommendations.

This performance audit is authorized pursuant to the City and County of Denver Charter, Article V, Part 2, Section 1, *General Powers and Duties of Auditor*, and was conducted in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We extend our appreciation to the DEN personnel who assisted and cooperated with us during the audit.

Denver Auditor's Office

A handwritten signature in black ink, appearing to read "Timothy M. O'Brien", is written over a light blue horizontal line.

Timothy M. O'Brien, CPA
Auditor



DIA Airside Construction Projects July 2017

Objective

The objective of the audit was to determine whether Denver International Airport's (DEN) Airport Infrastructure Management (AIM) Division has effective controls in place to ensure that airside construction projects are managed appropriately and address fraud, waste, and abuse. In addition, we determined whether construction projects are following various rules and regulations. We also reviewed AIM's internal controls surrounding the timekeeping process of staff augmentation contractors.

Background

The AIM Division is responsible for constructing, maintaining, and tracking DEN's capital assets as well as establishing quality controls and quality assurance for DEN's capital projects. As of 2015, DEN had approximately \$3.5 billion in capital assets. DEN's five year capital improvement program (2016 – 2020) includes an additional \$4.4 million that is estimated to be expended on airside pavement improvements.

REPORT HIGHLIGHTS

Highlights

Our evaluation of DEN's administration of airside construction projects identified weaknesses in DEN's Airport Infrastructure Management Division (AIM) that impact DEN's ability to execute airside construction projects in the most efficient and effective manner. Additionally, our evaluation identified weaknesses in DEN's Business Management Services Division (BMS) that affect the bidding process of airside construction projects.

Throughout recent years AIM has made significant positive operational and organizational changes. Although our audit has identified some areas of concern, we encourage AIM to continue incorporating improvements. Weaknesses in the AIM Division's practices identified in this audit include not having adequate controls in place to ensure that technical specifications are accurate and complete. Such weakness could lead to project delays, cost overruns, a reduction in airfield pavement service life, and maintenance cost increases. Additional weaknesses in the AIM Division's practices include failing to ensure that construction project files are maintained in accordance with policies and procedures, failing to have a structure surrounding the tollgate and lessons learned processes, and having project management software systems that duplicate and overlap with one another.

Weaknesses in BMS's practices include not having adequate controls in place to ensure that the information in airside construction bid documents is reviewed and aligned with BMS's standard operating procedures and failing to maintain the required support documentation for bids.

To enhance the administration of airside construction projects, we offer five recommendations to the AIM Division and two to BMS.

For a copy of this report, visit www.denvergov.org/auditor or contact the Auditor's Office at 720.913.5000.

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BACKGROUND

Overview of Denver International Airport

Denver International Airport (DEN) is located approximately 25 miles northeast of downtown Denver on 53 square miles of land, making it the largest commercial airport in the U.S.¹ The airfield—which is defined as the land that is used for aircraft takeoff, landing, and maintenance—includes six runways. Five of the runways are 12,000 feet long, and the sixth is 16,000 feet long—the longest commercial service runway in the United States. As the airport grows and expands its operations, the property can accommodate as many as six additional runways. Management of the airfield is handled by the Airport Infrastructure Management Division.

Airport Infrastructure Management Division Structure and Responsibilities

The responsibilities of the Airport Infrastructure Management (AIM) Division are carried out by four subgroups: Planning, Development, Maintenance, and Sustainability. The Planning subgroup is central to the AIM Division's operations by planning for all DEN future airside and landside projects, which includes providing timely input regarding development needs to Airport management, and setting the vision and strategic direction for the other three subgroups. Development, Maintenance, and Sustainability are responsible for the following areas:

- **Development Subgroup**
 - **Facility Delivery** – Manages the delivery of vertically constructed capital assets, such as buildings
 - **Infrastructure Delivery** – Manages the delivery of horizontally constructed capital assets, such as roadways, runways, taxiways, sewers, and non-building infrastructure assets
 - **Project Controls** – A Quality Assessment and Quality Control Subdivision establishes the quality controls and quality assurance for capital projects
- **Maintenance Subgroup**
 - **Facilities Maintenance** – Upkeep and repairs of vertical structures, plumbing, and buildings
 - **Field Maintenance** – All other upkeep and repairs outside of the purview of Facilities Maintenance
 - **Fleet Maintenance** – Upkeep and repairs of capital assets within DEN's fleet assets, such as snow removal, firefighting, and rescue activities
 - **Technical Maintenance** – Upkeep and repairs involving skilled labor activities, such as fire safety, access controls, and electrical

¹ DEN is Denver International Airport's IATA airport code, or location identifier, as established by the International Air Transport Association (IATA). Airport codes are generally named after the first three letters of the city in which an airport is located. Local users of Denver International Airport have traditionally referred to the airport not as DEN but as DIA, as has the Denver Auditor's Office in previous audit reports. However, DIA recently went through a rebranding effort, coinciding with the airport's 20th anniversary. The resulting look and feel of the airport's new brand incorporates its official IATA code—DEN—which is widely used and recognized by travelers worldwide. To support the airport in its branding efforts, we will from this report forward use DEN instead of DIA when referring to Denver International Airport in an abbreviated manner.

- **Sustainability Subgroup**

- **Environmental/Energy Management Team** – Ensure compliance with City code and environmental rules and regulations
- **Asset Management Team** – Maintain an asset inventory, including what assets are under DEN's control, where each asset is physically located, and a record of each asset's condition

The AIM Division's structure was designed to establish a cradle-to-grave process by which to track the life cycle of DEN's capital assets. Initially, the decision to implement a capital asset project begins with the Planning subgroup, then passes to the Development subgroup for the creation stage. When an asset is placed into operation, the Maintenance subgroup becomes responsible for upkeep and repair. This structure is intended to provide for better monitoring of capital assets.

Recent Enhancements within the Development Subgroup

The Development subgroup has recently placed greater emphasis on identifying process improvements, enhancing systems, updating procedures, and performing project control oversight. Following are three examples of the types of enhancements that have been made:

- **Best Practice Comparisons** – Leadership within the subgroup performs frequent comparisons between what the AIM Division is doing and industry best practices to identify areas for improvement.
- **Tollgate Meetings** – The Tollgate initiative establishes checkpoints coinciding with project milestones. These checkpoints provide formal opportunities for project managers, various stakeholders, and other AIM Division participants to make evaluations on project phases. These meetings are deliberate and structured and entail update briefs on areas such as budgets, construction progress, compliance issues, issues impeding progress, timetables, and plan deviations.
- **Lessons-Learned Meetings** – In addition to Tollgate checkpoints, a lessons-learned meeting is conducted at the end of each project with the intention of identifying and replicating what worked well during the project and to avoid what did not work well.

Key Systems Used by the AIM Division to Manage Airside Construction Activities

The AIM Division uses several information technology (IT) systems to carry out its responsibilities. Three were central to the work performed in this audit: Primavera Unifier, GIS05, and BIM 360 Field.

Primavera Unifier – Software for project managers that is utilized for designing, building, and managing facilities requires extensive collaboration between numerous groups and employees. Primavera Unifier (Unifier), an Oracle system, helps DEN manage the flow of project information throughout the facility lifecycle. AIM Division project managers use Unifier to track and manage budgets, project members, change management, submittals, requests for information, and shared documents. The system also allows users to manage all data and business processes in one centralized system, reducing the need for multiple channels of communication, such as email, fax, and desktop applications.

GIS05 – DEN uses one information technology server called GIS05 as a file storage database. This shared access point is used by AIM Division employees for saving contract documents related to

airside construction projects.² Additionally, documentation created while the project is being constructed such as submittals, change orders, requests for information, materials testing reports are all saved on the GIS05 server.

BIM 360 Field – During the construction phase of capital projects, AIM Division inspectors visit the job sites often and utilize this software as a daily reporting tool. BIM 360 Field allows them to manage field processes using mobile technologies, which are enhanced by cloud-based collaboration and reporting capabilities. The Library feature allows personnel to access project plans, checklists, and other documents on a mobile tablet, rather than having to bring paper to the job site or having to go back to the job site trailer or office to access the information. AIM Division inspectors use portable BIM 360 Field tablets to document their inspections, which are performed to ensure that contractors are performing work in accordance with project specifications. Real-time sharing and upload of information is intended to enhance efficiency.

Federal Regulations Are Intended to Establish Safety Standards and Guidelines for Denver International Airport's Airfield

The pavement used for airport runways, taxiways, and aprons must be constructed to provide adequate support for the significant loads imposed by the aircraft that park, taxi, take off, and land on those surfaces.³ These paved areas must be of sufficient quality and thickness to withstand the stress associated with aircraft use. The pavement must also be durable enough to withstand continual friction as well as fluctuating temperatures and adverse weather conditions.



Once paved areas are constructed, airports must prioritize the upkeep and repair of these surfaces to help ensure safe aircraft operations. Although deterioration is unavoidable, maintenance programs can help airport management monitor pavement condition to prevent severe damage or unsafe conditions. For example, pavement distress if left unaddressed can generate loose debris, which could strike and damage an aircraft. Not only is damage costly to repair, but undetected damage can compromise aircraft safety.

To maintain safe airfield operations, the Federal Aviation Administration (FAA) has established standards and guidelines for airport pavement design and evaluation. The Code of Federal Regulations (CFR) Title 14, Part 139 governs the Certification of Airports. To be certified by the FAA, an airport must apply for an Airport Operating Certificate as well as adopt and comply with an Airport Certification Manual. FAA Advisory Circulars contain methods and procedures for the development of an Airport Certification Manual, which should include a description of the airport's operating procedures, facilities and equipment, and responsibility assignments. Other required elements that are relevant to this audit are a description of each movement area

² The term "contract documents" describes the entire set of documents making up an airside construction project. Items such as bid documents, general specifications governing how work is to be performed at DEN in general, technical specifications, the executed contract between DEN and the contractor, and scope of work are all items included in the contract documents.

³ An apron is the area of an airport where aircraft are parked, unloaded, loaded, refueled, or boarded.

available for air carriers and its safety areas and procedures for maintaining the airport's paved areas.

Use of FAA standards and guidelines is mandatory for all projects funded under the federal Airport Improvement Program (AIP) or with revenue from the federal Passenger Facility Charge (PFC) program. DEN is a recipient of both fund types, and thus is subject to the standards. AIP provides grants to public agencies for the planning and development of public-use airports that are included in the National Plan of Integrated Airport Systems (NPIAS). On average, DEN participates in approximately \$35 million in AIP funding each year.

DEN's Pavement Management Program

The FAA created the concept of a Pavement Management Program (PMP) to assist airport management in making decisions about pavement maintenance and rehabilitation (M&R). Strategies crafted under a PMP should seek to balance maintaining the safety of paved surfaces while minimizing cost. Airports, like DEN, that receive federal AIP or PFC moneys are required to implement a PMP to help them determine the most economical way to spend these limited funds. At minimum, a PMP must include the following:

- A detailed inventory of all sections within a pavement network
- Detailed inspection of paved surfaces, at least annually
- Complete records of pavement inspections and maintenance
- The ability to generate reports on such information

The pavement conditions revealed by regular inspections can then be used to prioritize pavement repairs. DEN maintains pavement condition information in a system called PAVER, which is discussed later in this Background section of the report. Over the past ten years, DEN has received national awards from the American Concrete Pavement Association recognizing its excellence in project management and design and construction for airfield pavement projects.⁴

Pavement Condition Index – When pavement condition is evaluated, outcomes are measured using the Pavement Condition Index (PCI), which was developed by the U.S. Army Corps of Engineers. The PCI is a system that assigns a numerical rating to the surface condition of a pavement and indicates functional and structural performance. During an inspection, a technician identifies and measures visible distress on the surface of a defined paved area. Distress is then measured by type, severity, and quantity, yielding a value that represents the overall condition of the pavement section, ranging from 0 (Failed) to 100 (Excellent).

PCI is also indicative of the amount of work that will need to be performed to restore the surface to a safe and functional condition. For example, higher PCI values necessitate preventive maintenance while lower PCI levels necessitate reconstruction. Figure 1 shows more specifically that a PCI rating of 86 and greater is considered Good, indicating that the pavement is showing only minor distresses. At the other end of the spectrum, any section receiving a PCI rating of 10 or less is considered Failed, indicating that the pavement deterioration is significant enough to prevent safe aircraft operations.

⁴ The American Concrete Pavement Association is the world's largest trade association that exclusively represents the interest of those involved with the design, construction, and preservation of concrete pavements.

FIGURE 1. Pavement Condition Index for Airport Pavements



Source: DEN's 2015 Pavement Condition Report.

Determining PCI ratings is just the first step that airport management must take in determining M&R priorities. The key for the successful operation of a PMP is combining the objective assessment of pavement condition through PCI with more subjective criteria established by airport management. An airport must determine when a PCI rating will trigger maintenance for different surface types. For example, management might determine that they will not perform certain rehabilitation activities on airfield aprons until a surface reaches a PCI rating of Fair as opposed to Good. This threshold will likely be set at a higher PCI rating for runways, since they are more critical from a safety perspective.

To set its rehabilitation thresholds, DEN management contracted with consulting group Applied Research Associates, Inc., (ARA). ARA also provides pavement evaluation and management surveys to assess the condition of the DEN airfield. Prior to testing the quality of the pavement throughout the airfield, ARA and DEN established rehabilitation thresholds using a benchmark condition known as the Minimum Service Level (MSL). The MSL is defined as the minimum pavement condition acceptable for managing airside pavement. The benchmark MSL levels that are used to trigger rehabilitation at DEN are shown in Table 1.

TABLE 1. Minimum Service Levels at Denver International Airport's Airfield (PCI Ratings)

Runway	Taxiway	Apron
75	70	65

Source: DEN's 2015 Pavement Condition Report.

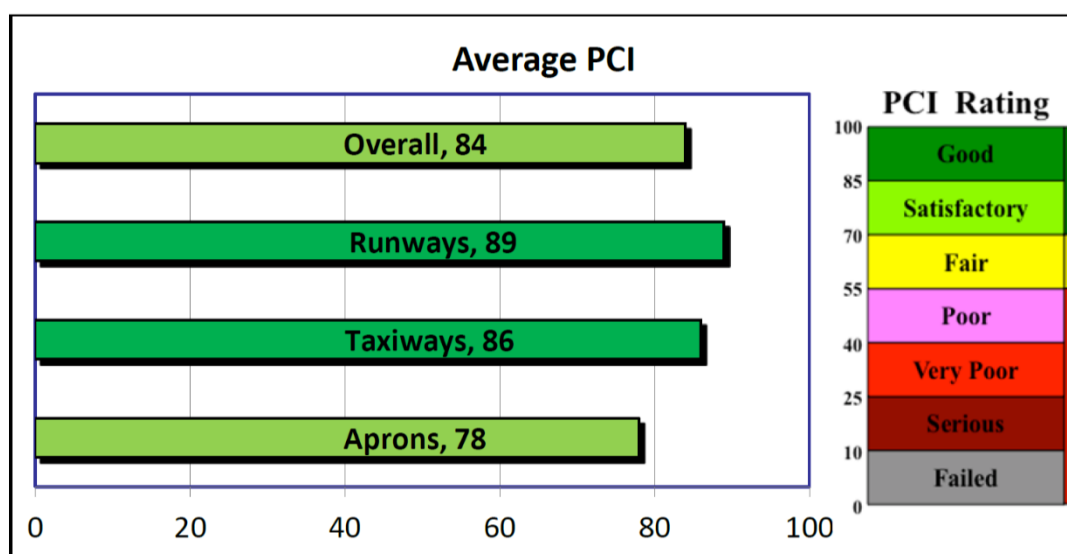
Based on the MSL, when a DEN runway receives a PCI rating of 75 or lower, DEN will commence repairs. Taxiway repairs do not commence until the condition reaches a PCI rating of 70; the apron threshold is even lower at a PCI rating of 65.

Applied Research Associates Conducted a Pavement Evaluation at DEN in 2015

The last time DEN conducted a pavement evaluation was in September and October 2015; ARA performed the evaluation. These assessments are done every three years, and the results of the assessment informs the PMP activities for the coming years.

According to the results of the 2015 ARA evaluation, the overall condition of DEN's runways is Good, based on the average PCI rating of 89. Taxiways also received a Good rating of 86. The average condition of all aprons fell into the Satisfactory category with a PCI rating of 78. These ratings, and the overall average PCI rating of 84, are shown in Figure 2. All ratings were above the MSL.

FIGURE 2. DEN Airfield Pavement Average PCI Rating by Type, 2015



Source: DEN's 2015 Pavement Condition Report.

ARA also projected out expected maintenance costs associated with maintaining the condition of the airfield. Table 2 summarizes the next five years of airside pavement improvements, which are currently included in DEN's capital improvement program (CIP). The estimated cost for scheduled M&R airfield projects through 2020 is approximately \$440 million.⁵ Pavement areas projected to fall below the desired MSL before 2021 that are not currently scheduled for rehabilitation are shown as an unmet backlog in 2021. The estimated capital project needs to maintain all pavements above the desired MSL through 2021 are approximately \$450 million, as noted in DEN's 2015 Pavement Condition Report.

⁵ Estimated cost for scheduled M&R is from DEN's 2015 Pavement Condition Report.

TABLE 2. Anticipated Airfield M&R Projects

Project Year	Calendar Year	Amount
Year 1	2016	\$ 71,800,000
Year 2	2017	206,900,000
Year 3	2018	154,900,000
Year 4	2019	1,300,000
Year 5	2020	3,500,000
5-Year Total		438,400,000
Unmet Backlog through 2021		11,200,000
6-Year Total		\$449,600,000

Source: DEN's 2015 Pavement Condition Report.

According to ARA's assessment, an additional \$24 million in preventive maintenance needs should also be programmed over the next six years, bringing the total airfield pavement M&R needs to approximately \$474 million. The five-year CIP will maintain the 2020 overall pavement network, on average, at a PCI of 85. The six-year CIP, including the 2021 unmet backlog projects, will also maintain the 2021 overall pavement network at an average PCI of 85. If no CIP actions are taken, the overall airfield PCI is projected to drop to 81 by 2020.

PAVER Software

DEN uses a pavement maintenance management system called PAVER to help manage M&R data. PAVER was originally developed in the late 1970s to help the U.S. Department of Defense manage M&R for its massive pavement inventory. The PAVER system uses inspection data and PCI ratings to help predict a facility's M&R needs. DEN uses PAVER to perform multiple levels of analysis to show where to best allocate the airport's M&R dollars. Data from PAVER is also used to compile the Pavement Condition Report.

Governance of the Bidding Process for Construction Projects

When DEN puts out bids for construction work on the airfield, it must comply with the provisions of Executive Order 8. Established in 2006, Executive Order 8 sets the policy and procedures for the preparation and execution of contracts with external parties to perform work on behalf of the City. The Order establishes a detailed process that construction projects must go through from the initiation phase through the subsequent steps of proposal, bidding, preparation for award, and contract execution.

The Denver Revised Municipal Code (D.R.M.C.) also governs DEN's actions with respect to the bidding process. D.R.M.C. Chapter 20, Article IV, which covers contracts, is relevant as well. Sections 20-62, 20-62.5, and 20-63 outline procedures for contracts, evaluation of bids, and bidding procedures, respectively. The provisions establish City policy, such as awarding contracts to the lowest qualified, responsive, and responsible bidder. The D.R.M.C. also defines what qualified, responsive, and responsible mean for the purposes of contracting.

DEN's Business Management Services Role in Airside Construction Project Contracting

The Business Management Services Division (BMS) is integral to the contracting process for airside construction projects at DEN. BMS assists with the development of the initiation of a project through a Request for Proposal (RFP), Request for Qualifications (RFQ), or Invitation for Bid (IFB). BMS coordinates the work of other divisions, ensuring that all required elements are present. These elements include scope of work, minimum qualifications or pre-qualifications, evaluation criteria, web links for accessing relevant information, and details regarding the communication process. BMS helps develop contract terms and timelines, performs valuations, and assists in the bid review process, which includes ensuring that a contract is reviewed by DEN's legal department and the Chief Executive Officer. BMS also maintains the bid information, including the actual contract.

OBJECTIVE

The objective of the audit was to determine whether Denver International Airport's (DEN) Airport Infrastructure Management (AIM) Division has effective controls in place to ensure that airside construction projects are managed appropriately and address fraud, waste, and abuse. In addition, we determined whether construction projects are in compliance with various rules and regulations. We also reviewed the AIM Division's internal controls surrounding the timekeeping process of staff augmentation contractors.

SCOPE

In assessing the AIM Division's administration of airside construction projects, we determined whether the construction process is in compliance with AIM project management guidelines, FAA regulations, and the City and County of Denver's contracting requirements. This included a review of construction projects in various phases to determine whether guidelines, regulations, and requirements are being followed.

METHODOLOGY

During the course of the audit, we performed the following steps to achieve the audit objective:

- Interviewing key personnel from the AIM Division and Business Management Services
- Reviewing various DEN and Federal Aviation Administration (FAA) rules and regulations and related reports
- Interviewing an FAA representative
- Reviewing various policies and procedures, including the City's Standard Specifications for Construction General Contract Conditions and AIM's Project Management Guidelines
- Reviewing various AIM reports, including Quality Control/Quality Assurance reports generated by AIM Division inspectors and contractors
- Reviewing materials testing reports generated by the materials testing laboratory for compliance with project specifications
- Reviewing internal and external audit reports related to airport and airfield construction projects and the federal Airport Improvement Program
- Reviewing relevant DEN and City financial data
- Reviewing AIM Division systems that are used to monitor construction and project management activities, including BIM 360 Field, GIS05, and Unifier
- Observing AIM inspectors conducting daily quality assurance activities
- Reviewing a specific runway project for compliance with various terms and conditions

- Reviewing a specific pavement rehabilitation project for compliance with various terms and conditions
- Reviewing BMS's standard operating procedures and governing guidance related to the bid process
- Assessing the design and implementation of internal controls over the staff augmentation timekeeping process for airside projects
- For purposes of this audit, we selected two airside construction projects to evaluate—Runway 17L-35R Complex Pavement and Lighting Rehabilitation and the 2016 Annual Airfield Pavement Rehabilitation. These projects were selected by meeting the following criteria: 1) the projects involved the construction or rehabilitation of airfield pavement; 2) the projects involved funding from the FAA's Airport Improvement Program; and 3) the projects progressed beyond the actual construction phase of the project and entered the close-out phase of the project.⁶

⁶ Airfield pavement includes runways, taxiways, and aprons.

FINDING 1

The Airport Infrastructure Management Division Should Improve Management of Airside Construction Project Execution

Efficient and effective management of airside construction projects requires Denver International Airport (DEN), through its Airport Infrastructure Management (AIM) Division, to perform certain actions. In evaluating the performance of these actions, we found weaknesses that impact the AIM Division's ability to optimally execute airside projects. We based these conclusions on our review of airside project files and processes surrounding the AIM Division's management of airside construction projects in comparison to best practices.

Based on our assessment, we found that the AIM Division needs improvement in two key areas. First, the approval process over technical specifications that are to be included in airside projects requires greater structure. Second, we found that the AIM Division should strengthen its project management guidelines and evaluate its current usage of project management software to eliminate duplication across systems. As such, we have made several recommendations to address weaknesses to ensure that the AIM Division is managing airside construction projects in a more streamlined manner.

The Airport Infrastructure Management Division Lacks Certain Controls Surrounding the Approval of Project Technical Specifications

In evaluating the AIM Division's process for ensuring that airside project technical specifications are accurate and up to date, we identified significant weaknesses. These weaknesses impact the AIM Division's ability to safeguard against a contractor using inaccurate specifications when constructing airside projects. Specifically, we found that the AIM Division lacks a sufficient process by which to ensure that the technical specifications provided to the contractor have been reviewed and approved.

DEN Airside Projects Must Meet Technical Specifications Based on Federal Aviation Administration Standards for Airport Pavement

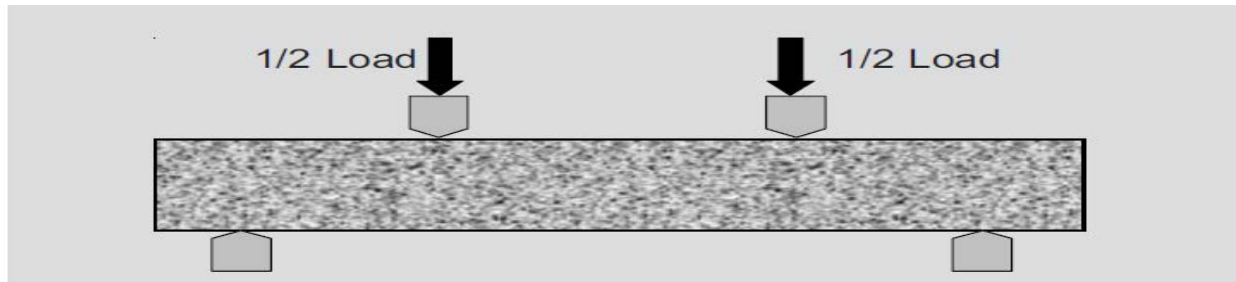
Contract documents for every DEN airside project always include technical specifications, which describe the quality and performance of required materials, incorporating code citations and published standards. Technical specifications detail explicitly the requirements that the product or assembly must meet or exceed for the contract to be fulfilled. In the case of airfield pavement, these requirements cover items such as the amount of admixtures, aggregates, and cementitious material and the degree of flexural strength.⁷

Flexural strength is a measure of tensile strength of concrete based on the ability of an unreinforced concrete beam to resist failure in bending. It is measured by loading a standard sized concrete beam into a machine that applies force, measured in pounds per square inch, continuously and without shock at a constant rate until rupture occurs. The flexural strength testing of airfield pavement is governed by ASTM Standard C78 – Standard Test Method for

⁷ Concrete is often referred to as cement; however, cement is the powder-like substance that, when introduced to water, crystalizes in the mixture to form concrete. Concrete is the finished product; cement is simply one of its main ingredients. Other ingredients include admixtures, water, and aggregates. Admixtures are chemicals added to the mixture immediately before or during mixing designed to achieve certain properties in concrete. Aggregates are ingredients such as sand and gravel used in the concrete mix. Cementitious material describes the type and proportions of cement used in the concrete mix.

Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading). The standard specifies that third-point loading consists of half the load being applied to each third of the beam's span length. This results in maximum stress being present over the center one-third portion of the concrete beam. Figure 3 depicts ASTM Standard C78 simple beam with third-point loading.

FIGURE 3. Depiction of Simple Beam with Third-Point Loading



Source: National Ready Mixed Concrete Association's concrete in practice guide for flexural strength testing, accessed May 31, 2017, from <http://www.nrmca.org/aboutconcrete/cips/16p.pdf>.

The Federal Aviation Administration (FAA) promulgates rules and regulations to govern airfield activity, including the construction and operation of runways, taxiways, and aprons. Accordingly, all airfield construction must conform to the FAA's technical specifications.⁸ DEN's specifications—Section P-501, Sub-section 3.02, Parts A and B—are the standards for DEN's airfield pavement technical specifications, which are based on FAA specifications. These provisions list the flexural strength requirements for airfield concrete. Part A specifies that concrete shall be designed to achieve a 28-day flexural strength that meets or exceeds 700 pounds per square inch (psi). Similarly, Part B specifies that concrete shall be designed to achieve a 72-hour flexural strength of 550 psi. This means that at 72 hours and 28 days, sample beams submitted for testing must be able to handle a minimum of 550 psi and 700 psi of force, respectively, without rupturing. If the test samples fail to meet these specifications, the corresponding concrete sampled must be removed from the airfield.

FAA Specifications Can Be Modified – Although the FAA's technical specifications set the standards to which airfield pavement must be constructed, instances do arise when the FAA specifications are modified. These deviations are referred to as "modifications." For instance, if the FAA specification calls for a specific material to be used in construction that is not readily available in the northwest mountain region of the United States, DEN may modify the specification to replace the material with a suitable substitute indigenous to DEN's geographic region. Section P-501, Sub-section 3.02, Part B of the airfield pavement technical specification is an example of a DEN modification. As noted above, Part B requires a 72-hour flexural strength of 550 psi. Part A, which represents the standard FAA flexural strength requirement, requires a 28-day flexural strength of 700 psi. Part B was a modification DEN added to exceed the FAA's standard flexural strength requirement.

Often, these modifications are the result of a project manager encountering a unique issue on a project and needing to make a modification to the standard FAA specification to address the issue. A modification such as this then remains in the specification to be used for future projects.

⁸ The Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5370-10, Standards for Specifying Construction of Airports, includes Item P-501 - Portland Cement Concrete Pavement. Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete.

The audit team was unable to determine when and why Section 3.02, Part B was added to the FAA P-501 specification, but we believe that it affected the structural integrity of a significant runway project in 2015.

DEN's Runway 17L-35R Rehabilitation Project Experienced Cracking

Modifying the FAA's standard flexural strength specification requires a contractor to then modify the concrete mix design to achieve the accelerated 72-hour flexural strength.⁹ An accelerated curing process of just 72 hours requires a mix that contains a much higher amount of cementitious material. The mix design submitted to DEN for approval by the contractor for Runway 17L-35R Complex Pavement and Lighting Rehabilitation Project (Runway 17L-35R Project) contained 700 pounds of cementitious material. The more cementitious material in the mix, the more heat is generated during curing. When cement combines with water, a heat releasing reaction occurs causing a temperature rise in the concrete.

Concrete has a low conductivity equating to a greater proportion of the heat being trapped in the center of the concrete runway panel and dissipating slower than the temperature at the panel's edges. The result is a temperature gradient between the panel's center and edges. This disparity in temperature creates stress on the concrete. If this stress surpasses the tensile strength of the concrete, cracking occurs.

Approximately 150 runway panels experienced cracking during construction of the Runway 17L-35R Project.



For the Runway 17L-35R Project, 150 of the 700 total runway panels poured experience cracking; 49 of the panels had cracking severe enough that the panels had to be removed and replaced in their entirety. As stated in the Section P-501 specification in Sub-section 4.19, if a crack extends into a new panel of a depth greater than four inches, the panel must be removed and replaced. The remaining 101 panels could be filled with a methyl methacrylate sealant.

Both DEN and the contractor obtained experts to determine the cause of the panel cracking with the

Runway 17L-35R Project. The contractor's experts concluded the following:

- The high cement content in the mix generated high heat during curing.
- The thermal gradient between the runway panels' interiors and exposed slump edges resulted in stress, which most likely caused the cracks.

DEN's experts concluded similarly that the high cement content in the mix generated heat during curing and the thermal gradient between interiors and edges resulted in stress on the curing runway panels. However, DEN's experts included an additional conclusion, as follows:

- Factors such as weather, temperature, wind, humidity, failing to prevent excessive drying by covering panel edges as they cured, and failing to provide the proper amount of topical cure to the curing concrete all could have played a role in the panels cracking.

⁹ Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability.

Although DEN approved the contractor's submitted concrete mix design, what appeared satisfactory with P-501 of the specification on paper did not translate to performance in the field. Once the experts concluded on the likely cause of the cracked panels, the contractor submitted a request to waive Sub-section 3.02, Part B from the Section P-501 specification. DEN's concurrence with the request resulted in a new mix design with a reduced amount of cementitious material. The amended mix design consisted of 611 pounds of cementitious material down from the original 700-pound mix. This new mix design resulted in the remaining pavement work being performed without issue.

The Part B Modification Was Unnecessary

Audit work found that Part B, Sub-section 3.02 of Section P-501 was not necessary as a modification to the airfield pavement technical specifications. Audit evidence indicated that this excessive modification contributed to the panel cracking experienced with the Runway 17L-35R Project. To come to this conclusion, we interviewed AIM Division personnel both in upper management and non-management positions, the project manager overseeing the Runway 17L-35R Project, and DEN's quality assurance inspectors assigned to the Runway 17L-35R Project. Additionally, we reviewed documentation detailing the panel cracking incident prepared by DEN as well as the project contractor and sub-contractor.

After the panel cracking incident, DEN took measures to improve its controls surrounding its project technical specifications. These measures included:

- Engaging an external engineering consulting firm to perform a comprehensive review of the AIM Division's existing airside specifications and removing unnecessary DEN modifications from the FAA's standard specification.¹⁰
- Giving custody of the airside specifications to the AIM Division's airfield engineering group to maintain the master set of specifications
- Allowing the project's designer of record (DOR) to make suggested modifications to the FAA specification when designing an airside project, which was previously prohibited
- Removing the FAA's blanket approval of DEN's modifications to the FAA standard technical specifications and implementing an item-by-item FAA approval on a project-by-project basis for all DEN modifications.¹¹
- Scaling back the magnitude of airside construction projects to make them more manageable for contractors and sub-contractors
- Working toward improving the criteria used to evaluate airfield pavement project bidders during the pre-qualification review process.¹²

In regard to the third measure mentioned above, according to AIM's Project Management Guidelines, the designer of record is the engineer/architect who designed the project. The DOR interprets drawings and specifications and monitors the work of critical construction activities. Prior to this change, DEN did not permit the DOR to question or suggest edits to the

¹⁰ Sub-section 3.02, Part B was one of the modifications removed from the Section P-501 specifications during this review.

¹¹ Prior to this change, modifications made by DEN to the standard FAA specification could avoid scrutiny because the FAA provided DEN with a blanket approval for its modifications.

¹² Currently the criteria category used to evaluate whether bidders can perform airfield pavement projects is for generic concrete paving and not specific to airfield pavement. The criteria that are in the process of being revised will be specific to airfield pavement, which should result in a better evaluation tool by which to identify qualified bidders.

specifications DEN provided to them. The DOR had to design the project according to the specifications provided without exception. Now, the DOR can suggest technical specification modifications that DEN can then take to the FAA for approval.

Despite these six improvements to the controls surrounding DEN's technical specifications, weaknesses remain. Audit work revealed that these weaknesses are significant enough that it remains possible for inaccurate airfield technical specifications to be included in projects going out for bid.

Despite Some Improvements, DEN Could Adopt Additional Best Practices

A leading government entity charged with establishing internal controls emphasizes the importance of providing controls that respond to operational risks. Guidance established by the U.S. Government Accountability Office (GAO) asserts that management must design controls to achieve objectives and respond to risks. These controls are created in the form of policies and procedures, techniques, and mechanisms that ensure management's directives are successfully executed. DEN's weak controls surrounding the technical specification approval process ultimately led to the panel cracking associated with the Runway 17L-35R Project. AIM Division management failed to adequately design controls to meet operational objectives related to project management by not having a process in place to ensure that airfield technical specifications were reviewed and approved for accuracy and completeness before going out for bid. Had the proper review and approval process been in place, it would have increased the likelihood that unnecessary and overly aggressive modifications—such as Part B, Sub-section 3.02 of Section P-501—would have been removed from the technical specifications.



DEN's Internal Control Deficiency Contributed to a \$2.9 Million Settlement

When contractors and sub-contractors bid on and subsequently construct airfield projects to inaccurate or outdated technical specifications, it reduces efficiency and effectiveness and ultimately can cost money. From an efficiency perspective, projects built to improper specifications can experience project delays extending beyond the target completion date. From an effectiveness perspective, building to the wrong specifications can drive up project costs as contractors use additional materials beyond the necessary project specifications or must demolish and re-construct the work upon discovering that the original work did not meet the excessively stringent specifications.

Despite the contractor's and sub-contractors' full awareness of what was expected of them when they bid on and were awarded the Runway 17L-35R Project, they did not accept fault for their ultimate inability to achieve the specifications laid out in Sub-section 3.02, Part B of Section P-501 without cracking. The following reasons were provided:

- The mix design was approved by DEN.
- The method of paving was approved by DEN and was compliant with the construction methods specified in Sub-section 4.01 of Section P-501..¹³
- The material used was approved by DEN.

DEN accepted partial responsibility of the panel cracking and reached a settlement with the contractor. Ultimately, the Runway 17L-35R Project was completed with a 38-day delay and an additional \$2.9 million settlement payout, bringing the total project cost to approximately \$38.3 million.

The total financial impact of not having adequate controls in place to review and approve technical specifications equaled \$2.9 million, in addition to the opportunity cost of not having use of runway 17L-35R for 38 days. Additionally, for the 101 runway panels filled with methyl methacrylate sealant, there could be future costs associated with possible service life reductions as well as an increase in maintenance costs throughout the service life of the panels.

RECOMMENDATION 1.1

The Airport Infrastructure Management Senior Director of Development should establish a process by which to ensure that all airfield project specifications are reviewed internally for accuracy and completeness and approved prior to being included in projects going out for bid.

Agency Response: Agree, Implementation Date – September 30, 2017

The AIM Division Lacks Proper Guidelines for Document Management

In addition to our findings related to the approval process surrounding technical specifications, audit work found that the AIM Division lacks formal policies for document management in its Project Management Guidelines (PMG). Throughout recent years AIM has made significant positive operational and organizational changes. Although our audit has identified some areas of concern, we encourage AIM to continue incorporating improvements. AIM has used the PMG as a resource for project managers who oversee each of the Division's construction projects since the last revision in May 2014. Due to process changes made during the course of the last three years, the PMG has become inaccurate when compared to the current project lifecycle as well as many of the electronic-file processing activities performed by AIM Division personnel.

There are three areas where this misalignment is most apparent: document management discrepancies, an absence of formal documentation surrounding Tollgate presentations and lessons learned, and duplicated project files across systems..¹⁴ AIM Division management is aware of the situation and is currently revising the PMG. Auditors were informed that the update

¹³ Sub-section 4.01 of Section P-501 addresses acceptable construction methods. Specifically, these methods cover the type of equipment that must be used and the required condition of such equipment.

¹⁴ Tollgate presentations are given at various stages of each project and act as a mechanism for the Project Manager (PM) to communicate the project status to various stakeholders. The meetings present an opportunity for dialog between the PM and AIM Division leadership before proceeding to subsequent phases of a project. Lessons learned are notes documenting specific items that could have been improved during the project for use on future projects. Capturing lessons learned is an ongoing process through the lifecycle of a project, starting with project setup and concluding with project closeout.

will occur in phases, targeting completion by the end of the summer construction season in 2017.

Current Internal Document Management Controls Are Deficient

In reviewing the AIM Division's project files, we found that many are missing, incomplete, or mislabeled. For some projects, multiple versions of the same document are present in the same system folder. We also found that final versions of documents are not clearly titled or maintained in project folders. Additionally, we noted that there are no standardized naming conventions for the project files within the AIM Division's primary document management system, GIS05..¹⁵

Our testing included a review of documentation in AIM's GIS05 project files for two of AIM's construction projects: the Runway 17L-35R Project and the 2016 Annual Airfield Pavement Rehabilitation Project. Specifically, we identified the following issues with the Runway 17L-35R Project:

- Six of 21 documents were missing
- Five of 21 documents were included with multiple versions in the project folders
- Three of 21 documents were found but not properly labeled

The 2016 Annual Airfield Pavement Rehabilitation Project testing resulted in similar findings, as follows:

- Twelve of 21 documents were missing
- One of 21 documents was present with multiple versions
- One of 21 documents was not properly labeled
- Three of 21 documents were incomplete

In assessing why these documentation issues occurred, we determined that the AIM Division's PMG does not specifically lay out procedures for document management for any of its software applications. Since the PMG does not reflect what is done in practice throughout the project lifecycle, project files are created inconsistently and are not maintained properly.

*Project files are
created inconsistently
and are not
maintained properly.*

The U.S. Government Accountability Office's (GAO's) Green Book emphasizes the importance of internal document-control standards and guidelines for the creation and maintenance of an efficiently functioning record-keeping system..¹⁶ Guidance established by GAO specifies criteria for documenting effective internal controls, which includes some of the following minimum requirements:

- Develop and maintain documentation of the internal control system
- Document the organization's internal control responsibilities in policies
- Evaluate and document any internal control issues as a result of ongoing monitoring and determine appropriate corrective action to address the issues on a timely basis

¹⁵ GIS05 is the file management system used by DEN. See Background section of the report for additional information about GIS05.

¹⁶ *Standards for Internal Control in the Federal Government*, known as the "Green Book," sets the standards for an effective internal control system for federal agencies and is also used as best practice for state and local government operations.

These internal management requirements and controls increase the likelihood of an efficiently operating business unit. In the absence of complete and accurate project documentation, AIM Division management and employees may miscommunicate about project tasks, which could result in project delays and overspending. This state can also create confusion for Contract Administrators and Project Managers, leading to preventable errors. Inefficiencies are generated and employees' productive hours are diminished when they cannot manage project files efficiently.

RECOMMENDATION 1.2

The Airport Infrastructure Management Senior Director of Development should ensure that project management files are maintained in accordance with policies and procedures, which shall include clear and proper labeling and final versions.

Agency Response: Agree, Implementation Date – September 30, 2017

Tollgate Presentations and Lessons Learned Forms Are Missing or Incomplete

During our review of GIS05 project files, we also noted a lack of documentation for Tollgate meetings and lessons-learned activities for both projects tested. Tollgate and lessons-learned are not documented and the final versions of Tollgate presentations or lessons-learned documents are not maintained properly within GIS05. However, progress meetings are held throughout a project lifecycle and the associated agendas are captured for reference. The existing Tollgate documents are not clearly labeled and properly stored in a location accessible by the PMs. Specifically, the Runway 17L-35R Project had three Tollgate documents of the four required, and the presentations were in varying states of completion. No Tollgate documents were found for the 2016 Annual Airfield Pavement Rehabilitation Project. Furthermore, we could not locate recorded lessons-learned forms for either project.

In assessing why Tollgate and lessons-learned activities are not being formally documented, we determined that the AIM Division does not have a procedural framework in the PMG for either one of these continuous-improvement activities. We did find a PowerPoint file explaining the Tollgate initiative, located in the AIM Division's archives. Regarding lessons-learned activities, we also located one standalone document on AIM's intranet website explaining the process. Without incorporating the execution of these activities into the AIM Division's processes, it is possible that they will not be performed consistently from project to project and that their benefits will not be fully realized.

According to the Project Management Institute, documenting lessons learned is an industry best practice for construction projects.¹⁷ Specifically, the AIM Division's PMG and the *Project Management Body of Knowledge* (PMBOK) both specify that lessons learned should be created and retained throughout each phase of a project and meetings should be held so participants can share what went well and what can be improved upon.¹⁸ The PMBOK does not specifically

¹⁷ The Project Management Institute is an organization that develops standards, performs research, and provides accreditation in project management.

¹⁸ The *Project Management Body of Knowledge* is a set of standard terminology and guidelines created by the Project Management Institute for project management including planning, organizing, staffing, executing, and controlling the operations of project management.

reference Tollgate meetings, but the PowerPoint file reviewed by auditors outlines requirements for the Tollgate initiative and the associated procedures. Our evaluation of the Tollgate presentations and lessons learned activities found that they enhance AIM's processes. However, a more formal structure is needed to fully utilize these tools so PMs can use the information for future projects.

According to AIM Division personnel, they are in the process of revising the PMG and do not intend to complete the revisions until the end of the construction season in 2017. The specific PMG section that will address both Tollgate meetings and lessons-learned activities has not been updated yet.

PM accountability can be difficult to guarantee if a process involving lessons learned and Tollgate reports has not been properly documented in the PMG and disseminated to the PMs. Avoidable mistakes may be repeated if lessons learned from previous projects are not convenient for PMs to access and apply to subsequent projects.

RECOMMENDATION 1.3

The Airport Infrastructure Management Senior Director of Development should document a formal process for Tollgate meetings in the AIM Division's policies and procedures and communicate the process to users.

Agency Response: Agree, Implementation Date – September 30, 2017

RECOMMENDATION 1.4

The Airport Infrastructure Management Senior Director of Development should document a formal process for lessons-learned activities in the AIM Division's policies and procedures, which should include how the data will be maintained and utilized for future projects.

Agency Response: Agree, Implementation Date – September 30, 2017

Project Documentation Is Maintained in Multiple Systems

The AIM Division uses several software programs to conduct daily business operations. We tested three of the systems during our audit: BIM 360 Field, used by AIM Division inspectors in the field to access construction documents; GIS05, used to manage all internal project documents; and Unifier, the AIM Division's new internal project-document managing software. Auditors discovered numerous instances of duplication of documents across these systems. For instance, bid submittals and Requests for Information (RFIs) have been stored in all three systems. Submittals are project drawings and material data used by architects and engineers to verify a project's feasibility. RFIs are used by the contractor to confirm a detail or specification of the project. Duplication is present across the AIM Division's software

AIM Division Contract Administrators spend 40 percent of their time uploading the same documents into three systems: BIM 360, GIS05, and Unifier.

packages since each class of employee has different business needs and not one software package fulfills the needs of every employee.

A Contract Administrator is assigned to manage the electronic files associated with a specific project and is usually the first person to experience the effects of document duplication. Contract administrators must spend approximately 40 percent of their time downloading, uploading, and moving required documents throughout the various systems. For example, if a project drawing is updated, it must be uploaded to all three systems so that the information is accurate regardless of what system an employee is using to access it. AIM Division personnel are aware of the duplication of efforts. However, the specific functionalities of the systems utilized by the various sections have been a priority over consolidation of records into one software system.

Best Practices Advise Against Excessive Duplication – Through annual reports on duplication and cost savings for federal agencies, GAO recommends reduction of duplicative systems and processes to improve efficiency and effectiveness. Reductions in fragmentation, overlap, and duplication will aid the efficacy of any organization.

In the case of duplication, there are no constraints specified in the AIM Division's PMG limiting the types and number of computer software systems that the Division is permitted to use in its operations. The root of the duplication issue can be traced to the diverse document-related needs of the varying divisions at the airport and the lack of integration between software packages in use. The AIM Division's deficiency of investment in alternative document-management solutions and IT systems analysis may be wasteful and lead to an inefficient use of employees' time moving documents between systems. Reducing duplication can improve the efficiency and efficacy of processes and procedures of an organization.

AIM Division leadership is aware of the inefficiency caused by the lack of system integration and has plans to more fully utilize its Primavera Unifier document management program with more of its employee roles.

RECOMMENDATION 1.5

The Airport Infrastructure Management Senior Director of Development should evaluate the current project management systems to ensure that functionalities are properly utilized and duplication of efforts is minimized.

Agency Response: Agree, Implementation Date – September 30, 2017

RECOMMENDATIONS

We make the following recommendations to the Airport Infrastructure Management Division to improve management of its airside construction project execution:

- 1.1 **Technical Specification Review and Approval Process** – The Airport Infrastructure Management Senior Director of Development should establish a process by which to ensure that all airfield project specifications are reviewed internally for accuracy and completeness and approved prior to being included in projects going out for bid.

Auditee Response: Agree, Implementation Date – September 30, 2017

Auditee Narrative: We have created a Technical Specification Writer position that is part of the Airport Infrastructure Management (AIM) Development Team, and who will assist in structuring and leading this effort. This position resides in our Project Management Office. All specifications will also be reviewed by our Quality Assurance/Quality Control management section prior to advertisement for bid. We will establish a verification process that will include the DOR (Designer of Record) as well as the Project Manager and the Quality Assurance Manager. This process will be incorporated into our Project Management Guide (PMG), and will be reviewed on an annual basis to ensure it is being properly administered and that the proper stakeholders are appropriately involved. We are targeting the release of the newly updated PMG by the end of September and will provide a final copy to your office.

- 1.2 **Document Management** – The Airport Infrastructure Management Senior Director of Development should ensure that project management files are maintained in accordance with policies and procedures, which shall include clear and proper labeling and final versions.

Auditee Response: Agree, Implementation Date – September 30, 2017

Auditee Narrative: AIM has been working toward implementing a standardized file structure. The Unifier document management program was recently selected as our project management database, and training has been on-going with our project managers and contract administrators. The PMG will be updated to include the policies and procedures that will govern our new file structure and it will be communicated to staff through our ongoing training sessions. The continued use and enhancement of Unifier will firmly establish a standardized file management program.

- 1.3 **Tollgate Process** – The Airport Infrastructure Management Senior Director of Development should document a formal process for Tollgate meetings in the AIM Division's policies and procedures and communicate the process to users.

Auditee Response: Agree, Implementation Date – September 30, 2017

Auditee Narrative: The tollgate process was created in 2016 and has been aligned with DEN Finances' business case development and capital planning approval process. We are formalizing a section in the PMG that will be dedicated to the tollgate process. Standard tollgate slide templates and guidance already exist and are available on our AIM Development SharePoint site.

- 1.4 Lessons-Learned Process** – The Airport Infrastructure Management Senior Director of Development should document a formal process for lessons-learned activities in the AIM Division's policies and procedures, which should include how the data will be maintained and utilized for future projects.

Auditee Response: Agree, Implementation Date – September 30, 2017

Auditee Narrative: The lessons learned process was created in 2016 working in coordination with the DEN Peak Performance office. We are formalizing a dedicated section in the PMG to the lessons learned process. A standard lessons learned library is also being formed in Unifier to provide a ready resource for project managers and contract administrators to reference for all future projects. Currently guidance exists on the AIM Development SharePoint site that will be incorporated into the PMG.

- 1.5 Project Management System Evaluation** – The Airport Infrastructure Management Senior Director of Development should evaluate the current project management systems to ensure that functionalities are properly utilized and duplication of efforts is minimized.

Auditee Response: Agree, Implementation Date – September 30, 2017

Auditee Narrative: This process has been on-going for the past two years as DEN has worked to integrate Unifier as our project management system of choice for operational development activities. AIM selected Unifier for its ability to align with our Project Management Lifecycle Map and create checks and balances for management to monitor all projects. We have been working to standardize the use of Unifier on all projects, both capital and O&M. AIM is currently reviewing the use of BIM 360 Field, which we are using for mobility in the field. Unifier recently added a similar modal capability which AIM is reviewing for single system integration. We are also exploring opportunities to link Unifier with standard WorkDay processes as well.

FINDING 2

The Bid Process Needs Improvement to Ensure That the Integrity of the Process Is Maintained

When Denver International Airport (DEN) airside projects are initiated, the City's formal bidding process is used to choose a contractor. Formal advertisement by official publication precedes the issuance of any bidder's proposal. The advertisement specifies the standards and specifications established pursuant to DEN's needs. The two airside construction projects included in our testing were the 2016 Annual Airfield Pavement Rehabilitation and the Runway 17L-35R Complex Pavement and Lighting Rehabilitation. Both projects were considered to be Invitation for Bids (IFBs) projects, and therefore, the bidders were selected based on the lowest responsive bid by a qualified bidder whose bid met all the requirements outlined in the Notice of Invitation for Bids. The lowest bidder is determined by the total contract bid amount. Our audit work sought to determine whether the contracts awarded complied with elements of the bid process. We identified a variety of weaknesses that impact the bid process.

Based on our assessment, we found that DEN's Business Management Services (BMS) Division needs improvement in two key areas. First, we found that the bid information that is advertised does not always align with bid practices and policies. Second, BMS does not always maintain the proper support documentation for each bid that is submitted. The discrepancies identified could result in questions about the integrity of the bid process because support documentation is not available for review, dates that bids are due and accepted are not clear, and information advertised to bidders is inaccurate. As such, we have made a few recommendations to strengthen control weaknesses and ensure that DEN's bid process is managed appropriately.

The Business Management Services Division Needs to Improve Controls Surrounding the Bid Process

In evaluating BMS's administration of the bid process for the two airside projects included in our testing, we identified control weaknesses that impact the integrity of the bid process. Administration practices that we found to be ineffective include bid information not aligning with bid practices and support documentation for bids not being maintained properly. A lack of proper administration in these areas precludes BMS from effectively managing the bid process.

Bid Information Advertised Does Not Align with Bid Practices

For the purpose of this audit, we conducted testing on the bid process for two airside projects. When reviewing bid documentation, we found that the due dates for IFBs on bid proposal documentation indicated a specific date, but BMS's standard operating procedures (SOPs) and current practices allowed bids to be submitted up until the bid opening, which is the day after the due date advertised. Specifically, for the 2016 Annual Airfield Pavement Rehabilitation Project, the bid due date was advertised as April 20, 2016. However, BMS accepted bids until the bid opening on April 21, 2016. In addition, the advertisement indicates that bid proposals will not be accepted at the opening.

A lack of proper administration precludes BMS from effectively managing the bid process.

We also identified other discrepancies between BMS's SOPs and the bid letter. The bid letter to the chosen contractor indicates that they have seven business days from the date of a written notice to deliver the signed contract, performance and payment bond documents, and the required insurance documents. However, BMS's SOPs note that the contractor has "generally" five business days to return the required documentation. Further, for this same bid documentation, the Notice of IFB and the bid letter included different dates regarding when the Notice of IFB was published.

Auditors learned that BMS's processes regarding project advertisement have changed throughout the years. The SOPs were updated accordingly but these changes did not align with the Notice of IFB documentation or the bid letters. BMS personnel were not aware of the discrepancies in bid advertisements, bid due dates, and the number of days allotted for contractors to submit additional information such as bonds and insurance certificates. When auditors reviewed the areas of misalignment with BMS personnel, they agreed that they need to be clarified.

The bid process has a variety of governing requirements, which includes the Denver Revised Municipal Code (D.R.M.C.), the City's Executive Order 8, and BMS's SOPs. According to BMS's SOPs, DEN is committed to a strong partnership with the business community and to ensuring that local businesses have viable opportunities in building DEN's future. Similarly, the City's and DEN's procurement procedures are designed to be fair, transparent, and to allow competition to thrive. In addition, Executive Order 8 provides guidance on advertising construction contracts, which includes specifics regarding bid opening date and proposal due date. Therefore, if this information is advertised incorrectly for DEN construction projects, the bid is not in compliance with Executive Order 8 because clear expectations regarding the project are not provided to bidders.

The discrepancies identified can result in questions about the fairness of the bid process, because it may appear as if bids are received after the due dates and that certain contractors are receiving preferential treatment. Inconsistent information advertised to bidders could have an impact on their proposals, and then providing chosen bidders with unclear guidance on when additional required documentation is due can cause confusion.

RECOMMENDATION 2.1

The Director of DEN Business Management Services (BMS) should ensure that the information in bid documents is reviewed and aligns with BMS Standard Operating Procedures.

Agency Response: Agree, Implementation Date – September 1, 2017

The Proper Support Documentation for Bids Is Not Maintained

We found that some of the bid documentation is not maintained properly by BMS. Our testing included verifying that bids were received by the advertised due dates and included the proper information for all bidders. However, BMS was unable to provide the original bid receipt documentation for either airside project tested. The 2016 Annual Airfield Pavement Rehabilitation Project had three bidders and the Runway 17L-35R Complex Pavement and

Lighting Rehabilitation Project had two bidders. In addition, the runway project had five addendums but only three of the five were provided by BMS.

As bids are submitted to BMS, bidders are provided receipts, and envelopes with the bid proposals are stamped with the date and time of receipt. Copies of these receipts and envelopes are to be kept by BMS. Since this part of the bid process is conducted and filed manually, at times the receipts are misplaced. BMS personnel are aware of the concern related to the management of these original documents and have discussed the need for improvement. Auditors requested bid documentation from BMS for the projects tested and, during an interview with personnel, we were informed that the runway project had five addendums. Upon reviewing the bid documentation, we found that only two of the addendums were included. As a result, this was discussed with BMS personnel and support documentation for the three additional addendums were requested. BMS personnel never responded with the additional information and did not provide an explanation.

According to the D.R.M.C., Chapter 20, Article IV, Section 20-62, every bid or proposal, with the name of the bidder or proposer, shall be maintained as a record with the successful bid or proposal and preserved for a period of five years and open to public inspection. In addition, Section 20-63 specifies that bid results shall be subject to inspection by competing bidders. BMS's SOPs indicate that any changes to the request for services document must be made in the form of an addendum. Addendums should be uploaded to DEN's website to ensure that all proposers have access to the same information.

If bid documentation is not maintained properly and original information related to bids is not available for review, the process is then flawed and can be considered unfair, not transparent, and non-compliant with governing regulations. Furthermore, if addendums are not properly shared, this can have an impact on bidders providing the correct pricing for work to be conducted, which can then result in increased project costs.

RECOMMENDATION 2.2

The Director of DEN Business Management Services should establish controls in the bid process, which require that the proper support documentation for bids is maintained.

Agency Response: Agree, Implementation Date – September 1, 2017

RECOMMENDATIONS

We made the following recommendations to Business Management Services to improve the bid process:

- 2.1 **Align Standard Operating Procedures with Bid Documents** – The Director of DEN Business Management Services (BMS) should ensure that the information in bid documents is reviewed and aligns with BMS Standard Operating Procedures.

Auditee Response: Agree, Implementation Date – September 1, 2017

Auditee Narrative: The DEN Director of Business Management Services (BMS) agrees that information in bid documents should align with BMS-Standard Operating Procedures (SOP's). DEN will review its procedures and bid documents to ensure alignment and consistency. Staff will be briefed on any modifications to BMS-SOP's, bid documents, and management will conduct periodic audits to ensure compliance.

- 2.2 **Maintain Supporting Documentation** – The Director of DEN Business Management Services should establish controls in the bid process, which require that the proper support documentation for bids is maintained.

Auditee Response: Agree, Implementation Date – September 1, 2017

Auditee Narrative: The DEN Director of Business Management Services (BMS) agrees that controls should be established in the bid process which requires that the proper support documentation for bids are maintained. Management will review the City and County of Denver (CCD) documentation retention policy, BMS-Standard Operating Procedures (SOPs), and ensure proper controls are in place for supporting documentation. Management will brief staff on CCD documentation retention policy, any modifications to BMS-SOP's, bid documents, and will conduct periodic audits to ensure compliance.

AGENCY RESPONSE



July 5th, 2017

Denver International Airport
8500 Pena Blvd.
Denver, CO 80249

Auditor Timothy O'Brien, CPA
Office of the Auditor
City and County of Denver
201 West Colfax Avenue, Dept. 705
Denver, Colorado 80202

Dear Mr. O'Brien,

The Office of the Auditor has conducted a performance audit of Denver International Airport Airside Construction Projects.

This memorandum provides a written response for each reportable condition noted in the Auditor's Report final draft that was sent to us on June 14, 2017. This response complies with Section 20-276 (c) of the Denver Revised Municipal Code (D.R.M.C.).

AUDIT FINDING 1

The Airport Infrastructure Management Division Could Improve Management of Airside Construction Project Execution

RECOMMENDATION 1.1		
The Airport Infrastructure Management Senior Director of Development should establish a process by which to ensure that all airfield project specifications are reviewed internally for accuracy and completeness and approved prior to being included in projects going out for bid.		
Agree or Disagree with Recommendation	Target date to complete implementation activities (Generally expected within 60 to 90 days)	Name and phone number of specific point of contact for implementation
Agree	September 30, 2017	Mark H Adams (303) 342-2762

Narrative for Recommendation 1.1

We have created a Technical Specification Writer position that is part of the Airport Infrastructure Management (AIM) Development Team, and who will assist in structuring and leading this effort. This



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position resides in our Project Management Office. All specifications **will** also be reviewed by our Quality Assurance/Quality Control management section prior to advertisement for bid. We will establish a verification process that will include the DOR (Designer of Record) as well as the Project Manager and the Quality Assurance Manager. This process will be incorporated into our Project Management Guide (PMG), and will be reviewed on an annual basis to ensure it is being properly administered and that the proper stakeholders are appropriately involved. We are targeting the release of the newly updated PMG by the end of September and will provide a final copy to your office.

RECOMMENDATION 1.2		
The Airport Infrastructure Management Senior Director of Development should ensure that project management files are maintained in accordance with policies and procedures, which shall include clear and proper labeling and final versions.		
Agree or Disagree with Recommendation	Target date to complete implementation activities (Generally expected within 60 to 90 days)	Name and phone number of specific point of contact for implementation
Agree	September 30, 2017	Mark H Adams (303) 342-2762

Narrative for Recommendation 1.2

AIM has been working toward implementing a standardized file structure. The Unifier document management program was recently selected as our project management database, and training has been on-going with our project managers and contract administrators. The PMG will be updated to include the policies and procedures that will govern our new file structure and it will be communicated to staff through our ongoing training sessions. The continued use and enhancement of Unifier will firmly establish a standardized file management program.

RECOMMENDATION 1.3		
The Airport Infrastructure Management Senior Director of Development should document a formal process for Tollgate meetings in the AIM Division's policies and procedures and communicate the process to users.		
Agree or Disagree with Recommendation	Target date to complete implementation activities (Generally expected within 60 to 90 days)	Name and phone number of specific point of contact for implementation





Agree	September 30, 2017	Mark H Adams (303) 342-2762
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Narrative for Recommendation 1.3

The tollgate process was created in 2016 and has been aligned with DEN Finances' business case development and capital planning approval process. We are formalizing a section in the PMG that will be dedicated to the tollgate process. Standard tollgate slide templates and guidance already exist and are available on our AIM Development SharePoint site.

RECOMMENDATION 1.4		
The Airport Infrastructure Management Senior Director of Development should document a formal process for lessons-learned activities in the AIM Division's policies and procedures, which should include how the data will be maintained and utilized for future projects.		
Agree or Disagree with Recommendation	Target date to complete implementation activities (Generally expected within 60 to 90 days)	Name and phone number of specific point of contact for implementation
Agree	September 30, 2017	Mark H Adams (303) 342-2762

Narrative for Recommendation 1.4

The lessons learned process was created in 2016 working in coordination with the DEN Peak Performance office. We are formalizing a dedicated section in the PMG to the lessons learned process. A standard lessons learned library is also being formed in Unifier to provide a ready resource for project managers and contract administrators to reference for all future projects. Currently guidance exists on the AIM Development SharePoint site that will be incorporated into the PMG.

RECOMMENDATION 1.5
The Airport Infrastructure Management Senior Director of Development should evaluate the current project management systems to ensure that functionalities are properly utilized and duplication of efforts is minimized.





Agree or Disagree with Recommendation	Target date to complete implementation activities (Generally expected within 60 to 90 days)	Name and phone number of specific point of contact for implementation
Agree	September 30, 2017	Mark H Adams (303) 342-2762

Narrative for Recommendation 1.5

This process has been on-going for the past two years as DEN has worked to integrate Unifier as our project management system of choice for operational development activities. AIM selected Unifier for its ability to align with our Project Management Lifecycle Map and create checks and balances for management to monitor all projects. We have been working to standardize the use of Unifier on all projects, both capital and O&M. AIM is currently reviewing the use of BIM 360 Field, which we are using for mobility in the field. Unifier recently added a similar modal capability which AIM is reviewing for single system integration. We are also exploring opportunities to link Unifier with standard WorkDay processes as well.

AUDIT FINDING 2

The Bid Process Needs Improvement to Ensure That the Integrity of the Process Is Maintained

RECOMMENDATION 2.1		
The Director of DEN Business Management Services (BMS) should ensure that the information in bid documents is reviewed and aligns with BMS Standard Operating Procedures.		
Agree or Disagree with Recommendation	Target date to complete implementation activities (Generally expected within 60 to 90 days)	Name and phone number of specific point of contact for implementation
Agree	September 1, 2017	Shala Sandoval 303-342-2657

Narrative for Recommendation 2.1

The DEN Director of Business Management Services (BMS) agrees that information in bid documents should align with BMS-Standard Operating Procedures (SOP's). DEN will review its procedures and bid documents to ensure alignment and consistency. Staff will be briefed on any modifications to BMS-SOP's, bid documents, and management will conduct periodic audits to ensure compliance.





RECOMMENDATION 2.2		
The Director of DEN Business Management Services should establish controls in the bid process, which require that the proper support documentation for bids is maintained.		
Agree or Disagree with Recommendation	Target date to complete implementation activities (Generally expected within 60 to 90 days)	Name and phone number of specific point of contact for implementation
Agree	September 1, 2017	Shala Sandoval 303-342-2657

Narrative for Recommendation 2.2

The DEN Director of Business Management Services (BMS) agrees that controls should be established in the bid process which requires that the proper support documentation for bids are maintained. Management will review the City and County of Denver (CCD) documentation retention policy, BMS-Standard Operating Procedures (SOPs), and ensure proper controls are in place for supporting documentation. Management will brief staff on CCD documentation retention policy, any modifications to BMS-SOP's, bid documents, and will conduct periodic audits to ensure compliance.

Please contact Mark A. Baker at (303) 342-2855 with any questions.

Sincerely,

Mark A. Baker
Senior Vice President, Airport Infrastructure Management

cc: Valerie Walling, Deputy Auditor, CPA,CMC
Sonia Montano, Audit Supervisor
Ken Greene, EVP Chief Operating Officer
Gisela Shanahan, EVP Chief Financial Officer



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