KUMASI INTERNATIONAL | AIRPORT EXPANSION | 2015-2021

NURIZON
CONSULTING ENGINEERS

ENGINEERING SOLUTIONS INSPIRED BY VISION

INTRODUCTION

PROVIDING UNIQUE, INNOVATIVE AND COST-EFFECTIVE ENGINEERING SOLUTIONS SINCE 2010

Kumasi International Airport (IATA: KMS) located in Kumasi, the capital city of Ashanti, Ghana, is operated by the Government of Ghana. The airport offers international and domestic aviation services to passengers in the Ashanti region and nearby areas. It is regarded as one of the busiest international airports in the country. Known for its regional airline operations, the airport had to undergo an expansion to transform it into a full-fledged international airport.

The expansion project formed part of the multi-modal transportation system being developed by the government to enhance tourism in the Ashanti Region. The airport has witnessed a steady rise in passenger traffic over the recent years. The expansion aims to serve the growing demand by adding capacity to serve international passengers.

Nurizon International Limited was appointed by Contracta (the design-build Contractor for the project) to undertake the engineering design of the Kumasi International Airport (KMS) upgrade.

The scope covers

i) airside and landside infrastructure as well as

ii) the new terminal building.

It includes civil, structural, mechanical, electrical, and communications designs.

bsi. ISO 9001:2015 Quality Management

FS 691370

The existing airport at Kumasi currently caters to the domestic market. It is located at a distance of 5.5 km from the city centre. The existing airside facilities comprises of a runway, designation 02-20, stopways at each end, and an aircraft parking apron connected by a short link taxiway. The runway is classified as a Code 4C runway. The runway is furthermore categorised as a non-instrument runway even though an Instrument Landing System (ILS) is provided on Runway 20. This is due to the lack of sufficient runway strip width and positioning of buildings on the airport. The existing runway, link taxiway and apron were constructed in the 1960's and upgraded within the past few years. Ghana Civil Aviation Authority (GCAA) has decided to upgrade the existing runway, Airfield Ground Lighting (AGL) System, and bulk service infrastructure to accommodate the Boeing 737-800 as the design aircraft. Construction of a new terminal building, link taxiway, apron, service roads, new parking facilities, and access roads will also be undertaken at the Airport as part of Phase II and III of this project. Phase I included an overlay of the existing runway and was completed two years ago.

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SCOPE OF SERVICES

GEOTECHNICAL INVESTIGATION

The purpose of the geotechnical investigation for the Kumasi International Airport was to obtain information regarding the geology and engineering properties of the insitu material, in terms of the foundation and pavement design for the following project elements:

- Runway Extensions (pavement design);
- Apron (pavement design);
- Terminal Building (bulk earthworks and foundation design);
- Air Traffic Control (ATC) Tower and Emergency Services Building (bulk earthworks and foundation design).
- Parking Area (pavement design); and
- Access Road (pavement design).

The geotechnical campaign consisted of:

- Desk study;
- Trial pitting (excavated by a TLB);
- Plate load testing;
- Borehole Drilling and SPT testing (21m depths);
- Dynamic cone penetration tests (DCPT) – up to 5m depths;
- Laboratory Testing;
- Analysis and Reporting.

SCOPE OF SERVICES

airside

EXTENSION OF EXISTING RUNWAY

- Mass earthworks;
- Pavement Design;
- Drainage Design;
- Markings and Signage;
- Determination of PCN of all new and existing pavements (apron, link taxiway, runway etc.);
- Assessment of suitability of existing ATC Tower for aircraft operations;
- Assessment of suitability of existing pavement for B737-800 operations; and
- Employer's requirements

NEW APRON, LINK TAXIWAY, AND SERVICE ROAD

- Earthworks;
- Pavement Design;
- Drainage Design;
- Markings and Signage;
- Correction of existing apron slopes to conform to ICAO requirement;
- Ducts and sleeves for future fuel hydrants on apron; and
- Determination of PCN of all new and existing pavements (apron, link taxiway, runway etc.)

AGL AND NAVAIDS DESIGN

- Runway lighting;
- Approach lighting;
- Taxiway and apron lighting;
- Instrument Landing System (ILS); and
- Precision Approach Path Indicators (PAPIs)

SCOPE OF SERVICES

landside

TERMINAL BUILDING

- Architectural Design
- Earthworks and Foundations;
- Retaining structures;
- Structural Design;
- Baggage Handling;
- Electrical, Electronic and Communications;
- Air Conditioning and Ventilation;
- Fire Protection; and
- Wet Services

MAIN UTILITIES AREA

- Main substation building;
- Generator Fuel Storage;
- HVAC Area, housing the chiller units;
- Fire Water Storage Tank;
- Fire Water Pump Station (Containerized)
- Potable Water Storage Tank;
- Potable Water Booster Pump Station (Containerized)

FENCING

- Security Fencing; and
- Security/Perimeter Fencing – Limited amount of security/perimeter fencing works included in this project.

AIR TRAFFIC CONTROL TOWER AND EMERGENCY SERVICES

- Architectural Design
- Earthworks and Foundations;
- Structural Design;
- Internal Walls, Openings etc.;
- Electrical, Electronic and Communications;
- Air Conditioning and Ventilation;
- Fire Protection; and
- Wet Services.

EXTERNAL WORKS (LANDSIDE)

- Bulk Services, including potable water, fire water, sewer, and electrical;
- Access Roads;
- Car Parks;
- Substation;
- Upgrade of Power System; and
- Fire Protection and Water storage.

GEOTECHNICAL INVESTIGATION

The geotechnical campaign included the airside and landside infrastructure, the new terminal building, new Air Traffic Control (ATC) Tower and Emergency Services Building (ESB). The purpose of the geotechnical investigation was to obtain information regarding the site conditions in terms of:

- The geology of the site (Kumasi International Airport, Phase II and III);
- Determining the soil profile, engineering properties and workability of the material, including the identification of problematic soil conditions;
- The level of bedrock;
- The presence of groundwater; and
- Provide foundation and pavement design input.

The detailed geotechnical campaign comprised of the following activities:

- Detailed desk study;
- Trial Pitting, excavated up to 6m depths;
- Rotary core drilling (up to 21m depths) and SPT testing;
- Dynamic cone penetration testing (DCPT), up to 5m depths;
- Soil Profile Logging and sampling (disturbed and undisturbed);
- Laboratory testing of the soil samples;
- Analysis and Reporting (Factual Report).

A detailed geotechnical investigation was required in order to characterise the nature and distribution of the geotechnical properties of the site to permit acceptable design, construction and the operation of the proposed works.

Site investigation is a complex scientific process that is vital to any construction project. Inadequate investigation can lead to over conservative designs and significant variation during construction which can lead to delays and unforeseen costs. Equally it can lead to failures during or after construction resulting in damage to property, consequential damages or even loss of life. Unforeseen ground conditions can have enormous cost and programme implication for a project. The geotechnical investigation commenced during October 2017.

EXTENSION OF EXISTING RUNWAY

The Kumasi International Airport's runway was designed to be extended as follows

- Total runway length available for take-off is 2,320m in the predominant take of direction;
- Additional 60m paved area in front of threshold provides the runway length required as per the employer requirement; and
- The above has been discussed and agreed with GACL and GCAA.

The runway was designed as a code 4D precision approach runway. This implies a 150m wide strip on either side of the runway centreline as opposed to the existing 75m width.

The critical aircraft (design aircraft) for the Kumasi International Airport were:

- **ERJ-145;**
- **BAE-145; and**
- **Boeing B737-800.**

The paint markings for the runway included:

- Runway designation marking, i.e. Runway '20' and Runway '02';
- Runway centreline markings;
- Threshold markings;
- Transverse strip and pre-threshold displacement markings;
- Aiming point markings;
- Touchdown zone markings; and
- Runway side stripe markings.

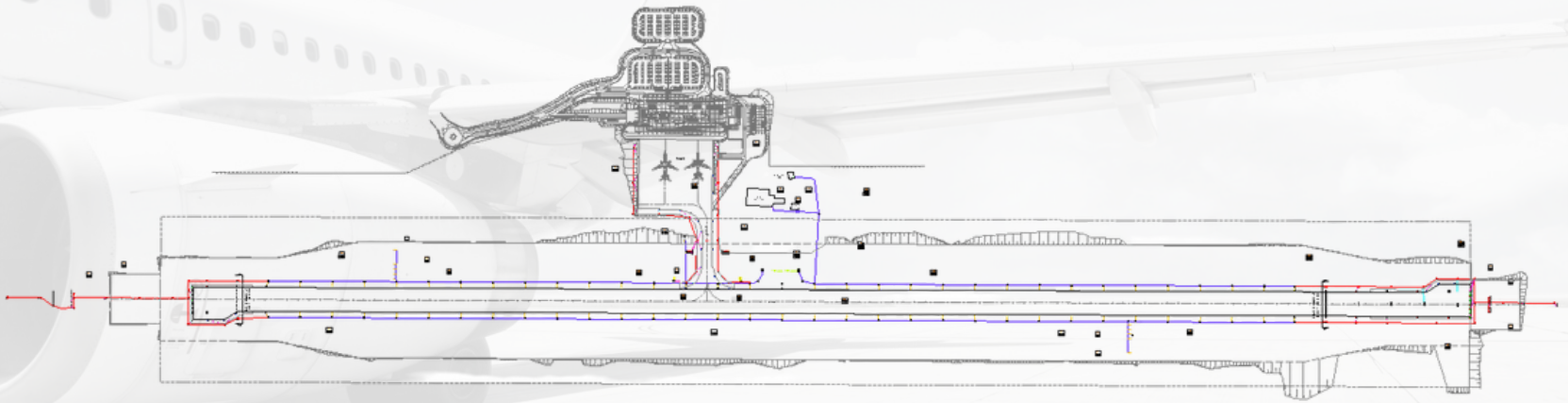
Kumasi International Airport's existing runway was extended on the southern and northern sides, to accommodate the critical design aircraft (Boeing B737-800W (with winglets)). The runway was designed as a code 4D precision approach runway, as per ICAO annexure 14 specifications.

EXTENSION OF EXISTING RUNWAY

The runway strip design for the runway upgrade at KMS assumes a was done for a Precision Approach Category I runway, as described in ICAO Annex 14 (ICAO, 2016) with a width of 150m either side of the runway's centreline and 60m preceding either threshold. A graded strip width of 75m either side of the runway centreline is required provide, inclusive of a 7.5 m wide runway shoulder. The graded strip is 105m wide.

Description	Recommended value
Runway Width	45 meters
Longitudinal slope	1% except for 1st and last quarter of the runway slope not to exceed 0.8%
Longitudinal rate of slope change	0.1 percent per 30m, translates to a K-value of 300
Runway transverse slope	1.5%
Runway strip transverse slope	Not to exceed 2.5%
Runway strip longitudinal slope	Not to exceed 1.5%
RESA longitudinal slope	Not to exceed 5% upward or downward
RESA transverse slope	Not to exceed 5% upward or downward

The strip was regraded in order to allow for the correct drainage of the runway and strip. The Runway extensions, turn pads, and RESA areas were designed as per ICAO annexure 14 specifications at both ends of the runway.



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NEW APRON, LINK TAXIWAY, AND SERVICE ROAD

TAXIWAY

A new taxiway link was designed as a Code 4D taxiway with shoulders as per ICAO specifications and recommendations.

It is an 18m wide taxiway with 10m shoulders on either side. The taxiway's length and position was influenced by the apron's required offset from the runway centreline with regards to clearances and strip widths.

The apron and taxiway design standards used to do the geometric design can be summarized as follows:

NEW APRON, LINK TAXIWAY, AND SERVICE ROAD

APRON

Two new apron stands (17,500m2) were required as part of the design criteria. The stand requirement wass for power-in push back stands (for two B737-800s). The apron was sized and positioned considering a mix of alternative Code C aircraft.

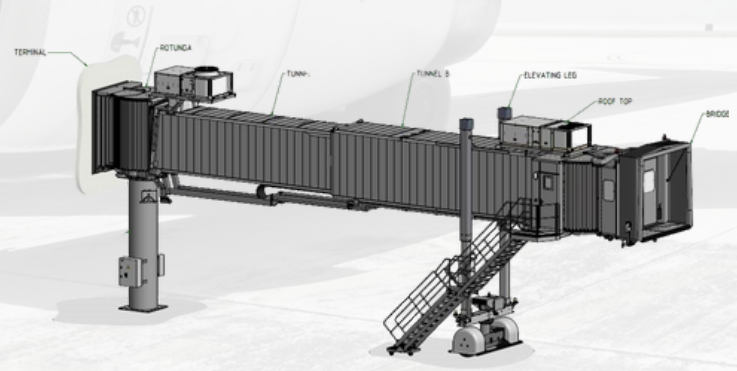
The stand was positioned at the correct offset from the centreline of the runway as to ensure that the Code 4D Precision Approach, Category I runway's vertical and horizontal clearances are adhered to. The provision of a future parallel taxiway was also taken into consideration in the positioning and design of the apron. The existing apron was not positioned far enough from the runway centreline to allow for the 150m strip as required. The new apron is located to the south of the existing apron.

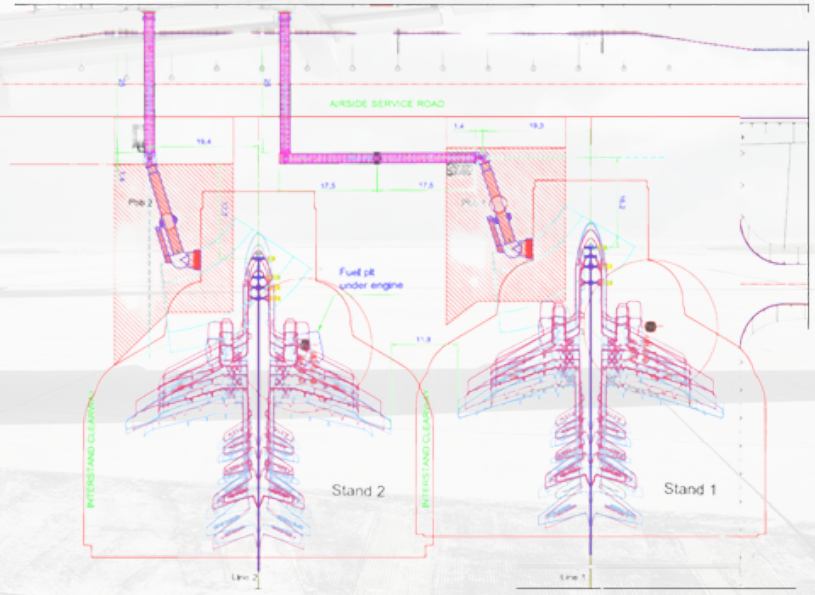
Description	Recommended value
Taxiway width	18 meters
Taxiway Shoulder width	10 meters
Longitudinal slope	Not to exceed 1.5%
Longitudinal rate of slope change	1 percent per 30m, translates to a K-value of 30
Taxiway transverse slope	Not to exceed 1.5%
Apron Slope	Not to exceed 1%

The apron was sized using aircraft tracking software to ensure that all the requirements of the standards are met.

PASSANGER BOARDING BRIDGES

As part of the scope, two Passenger Boarding Bridges (PBB) connected to the terminal building by means of a fixed bridge sections were to be be installed to service the contact stands.





NEW APRON, LINK TAXIWAY, AND SERVICE ROAD

ATC (Air Traffic Control Tower) and ESB (Emergency Services Building)

Kumasi International Airport's Air Traffic Control Tower (ATC) and Emergency Services Building (ESB) was designed to be a combined building, which includes the following facilities:

ATC:

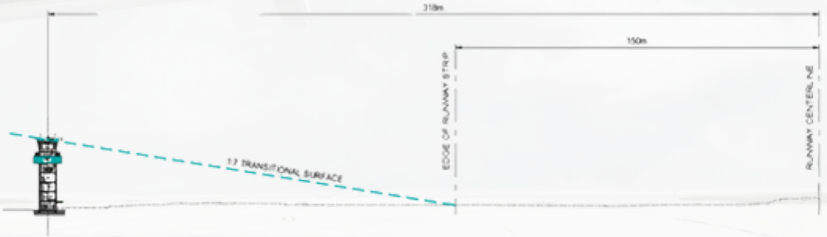
- Security Control Room
- Mechanical and elevator equipment room
- General facilities, storage and ablutions
- Administrator and Assistant offices
- Regional Chief Office
- Communication Equipment room
- HVAC Equipment Isolation room
- Meteorological office
- CNS Equipment room
- Approach Control room
- Approach Control room (additional area)
- Visual Control Room

TOWER HEIGHT

The Air Traffic Control (ATC) tower has a total height of 27m, which was calculated based on the

(i) Line of Sight Angle of Incidence and the

(ii) Transitional Surface.



ESB:

- Generator / Electrical Room
- Pump Room
- General facilities and storage
- Foam and Equipment Store
- Gym, change rooms and ablutions
- Emergency Operations Center (EOC)
- EOC Communications and Secretariat Office
- Rescue and Firefighting Services (RFFS) Office
- IT Room
- Watch Room

NEW APRON, LINK TAXIWAY, AND SERVICE ROAD

AIRSIDE ACCESS ROAD

The airside access road connects the ramps from the basement services tunnel.

The access road has the following cross-sectional elements:

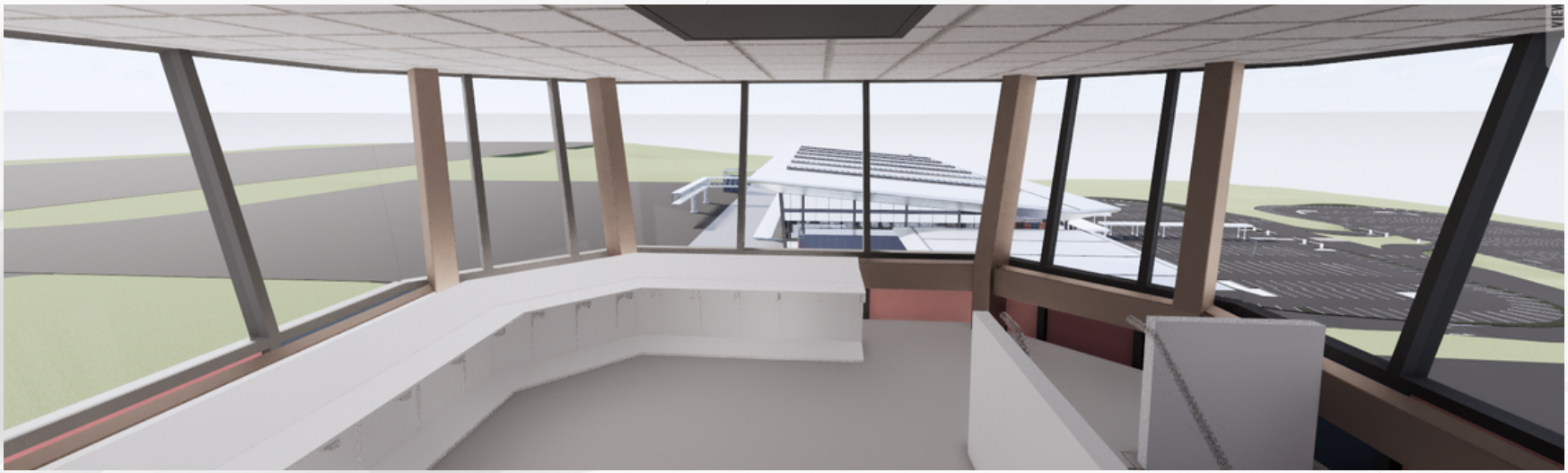
- Mountable kerbs in front of the terminal building on the terminal side and no kerbs on the apron side;
- Two 6m single lanes in same direction with no median (12m total);
- 3m bus lane; and
- 1% crossfall towards the apron on the lanes.

APRON ACCESS ROAD

The apron access road is provided to have access to the apron from the existing Fire Fighting Building.

The access road has the following cross-sectional elements:

- Barrier kerbs in both sides of the road.
- 2 off 3.5m single lanes in different direction with no median (7m total);
- Maximum of 4% super elevation at the bend.



A new taxiway link was designed as a Code 4D taxiway with shoulders as per ICAO specifications and recommendations. The apron was designed for two(2) Boeing B737-800s (power-in push back stands), taking into account a mix of alternative Code C aircraft. The apron was positioned to ensure that the Code 4D Precision Approach, Category I runway's vertical and horizontal clearances are adhered to, with also provision made for a future parallel taxiway.

AGL AND NAVAIDS DESIGN

SCOPE OF WORKS

- 420m Barrette centreline simple approach lights for non-precision operations for runway 20 approach (replace existing system);
- 420m single source centreline simple approach lights for non-precision operations for runway 02 approach (new approach);
- Inset runway threshold lighting for each landing direction and runway end lights to mark the limits of the runway;
- Modifications to the existing runway edge lighting to modify the runway coding (Y/W filters) & inset fittings;
- Elevated runway turn pad edge lights (LED);
- Elevated and inset runway edge lights along the new runway extension;
- Blue taxiway elevated edge lighting (LED) along the new apron;
- Taxiway Guidance Signs and Information Signs (LED type);
- Removal and reinstallation of the existing PAPIs (to allow the civil contractor to repair the concrete base);
- AGL primary and secondary cables and secondary isolating transformers;
- Constant Current Regulator for new approach 02 circuit; and
- Modifications to the existing AGL control system to accommodate the new approach lights and the update of the mimic.

CIVIL WORKS

- Identify, coordinate (liaise with civil contractor) and acceptance (from civil contractor) of AGL civil works prior to commencing any installation work;
- The marking/labelling all AGL pits, transformers, incoming and outgoing cables and all other items of AGL located in pits;
- Installation of counterpoise earthing cables, earth bars and the earth rods in pits in accordance with the technical specification and the project drawings;
- The coring and installation of shallow bases for inset light fittings within the pavement where indicated in the project drawings and AGL design. Shallow bases positioned, set in, and accurately aligned to ensure the light output from each inset light fitting is at the correct azimuth and elevation;
- Installation and termination of all AGL fittings, frangible couplings, masts, foundation bolts, secondary cables, secondary isolating transformers, primary cables and primary joints; and
- Installation and commissioning of a new fibre optic ring connections between existing AGL substation and the new ATC.

AGL AND NAVAIDS DESIGN

airside

PROPOSAL DOCUMENTATION

- Brief design summary;
- Detailed description and specification of all proposed equipment;
- List of all spares to be provided;
- Statement of compliance/ non-compliance;
- Programme of works;
- Draft 'Quality Plan'; and
- Draft 'Health & Safety Plan' for all site works.

The Aeronautical Ground Lighting (AGL) and Navaids were designed for the Kumasi International Airport' runway (02 - 20) and connecting taxiway. This system provided will be suitable for all weather operations up to and including Category I meteorological conditions.

TERMINAL BUILDING

SCOPE OF WORK PHASE II AND PHASE III

Scope of work for technical documentation:

- General arrangement drawings and working layout drawings (including all plans, sections and elevations);
- Curtain wall schedules, including glazing and systems;
- Internal shopfront schedules;
- Door schedules, including ironmongery;
- Sanitary and Brassware schedules;
- Finishes schedules (hard finishes only excluding soft finishes);
- Horizontal waterproofing specifications and detailing;
- Roof assembly details and specifications; and
- Bathroom layouts.

TERMINAL BUILDING

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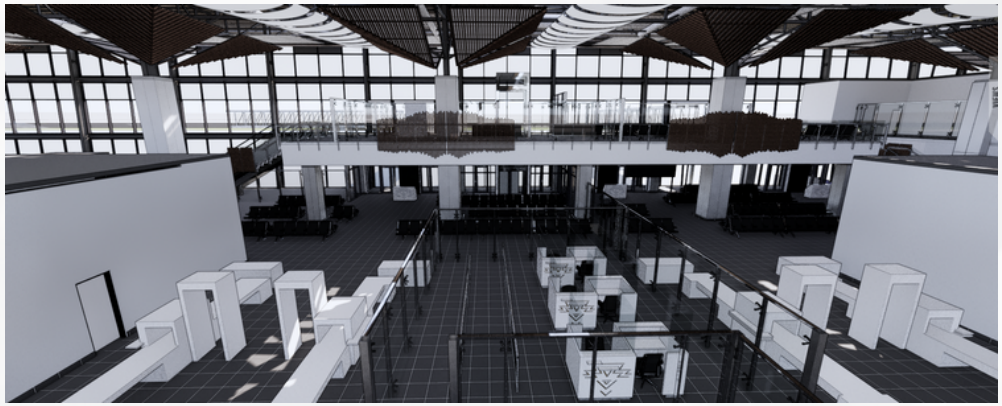
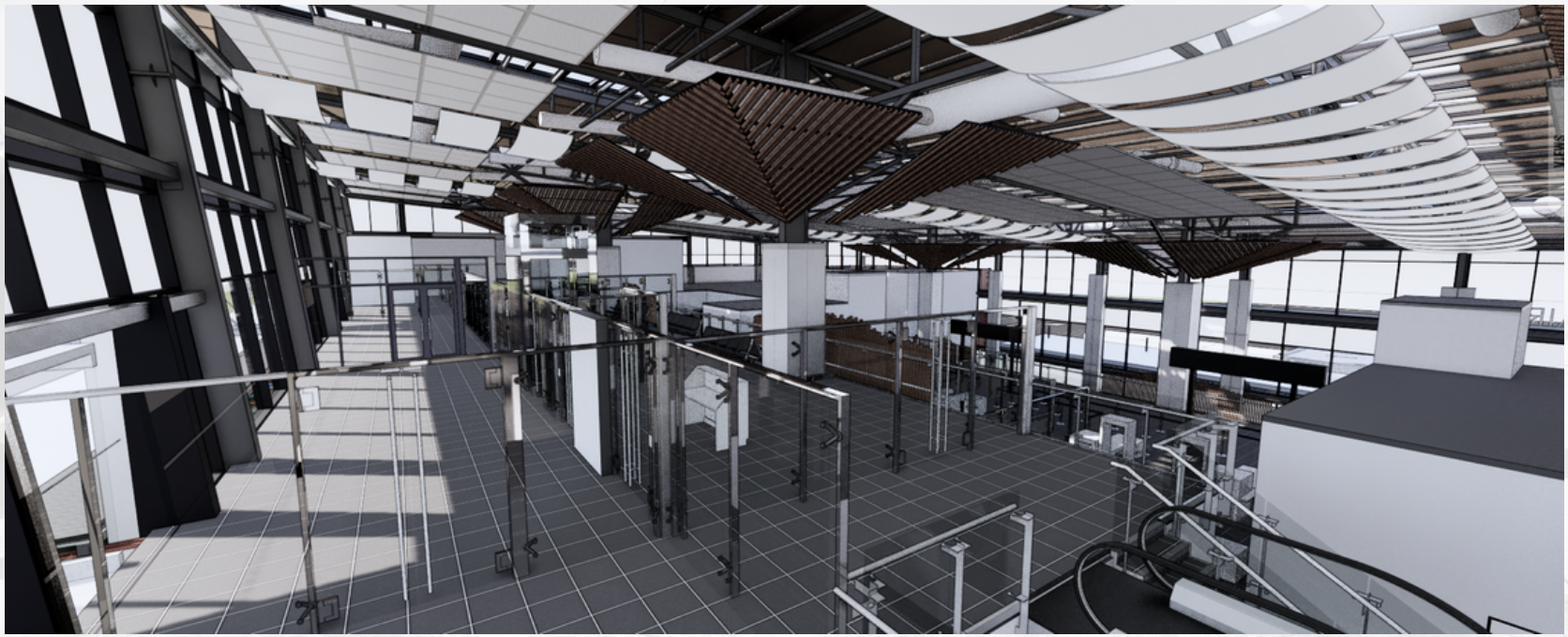




TERMINAL BUILDING

PHILOSOPHY OF DESIGN

In attempt to add meaning and layering to the expression of the terminal building, several themes and local influences were explored.
Through this research, inspiration was drawn from the rich cultural history of the area:

- Allegorically, the name **Kumasi means 'Under the Kum Tree'**, and draws upon the rich legacy of the Kumasi region and its founding in Ashanti lore. History has is that high priest and royal advisor, Okomfo Anokye, planted two trees in two villages in the Ashanti Kingdom. This was apparently to decide which of these two towns would be the capital or soul of the Ashanti Kingdom. One of the trees died and as such, that village was called Kumawu, but the other village was called Kumasi.
- Inspired by the name Kumasi, the concept of 'under the Kum tree' was translated into the terminal building and architecturally expressed through the primary column grid structure. The distinct V-shape decorative columns are used to support the building's lightweight steel roof structure, creating a voluminous and uninterrupted space within the building.

TERMINAL BUILDING

PHILOSOPHY OF DESIGN

In addition to the feature columns, natural roof lights are used in conjunction with traditional textiles and fabric shading clothes that celebrate the Ashanti culture to create a soft and dappled lighting effect within the building, similar to that of being underneath a tree. The tiling pattern on the floor are similarly use to represent this dappled light effect, and use a combination of muted greens, reds and yellows in conjunction with grey to create a distinct mosaic pattern surrounding the column trees.

Externally, the solid 'bookends' that frame the building's glazed entrance facade will be articulated by means of decorative composite panels and powder coated baguettes - designed as a stylized representation of the vertical 'warp' yarns (the ACM panels) and horizontal 'weft' yarns (the baguettes) of a traditional handwoven Ashanti Kente fabric.

TERMINAL BUILDING

landside

The following main changes were incorporated from Phase II to Phase III of the terminal building:

- The floor areas were increased (as shown in the table below);
- The additional of a Mezzanine level. The mezzanine level was included in Phase II, but only the structural slab. This was due to ease of construction during Phase III.

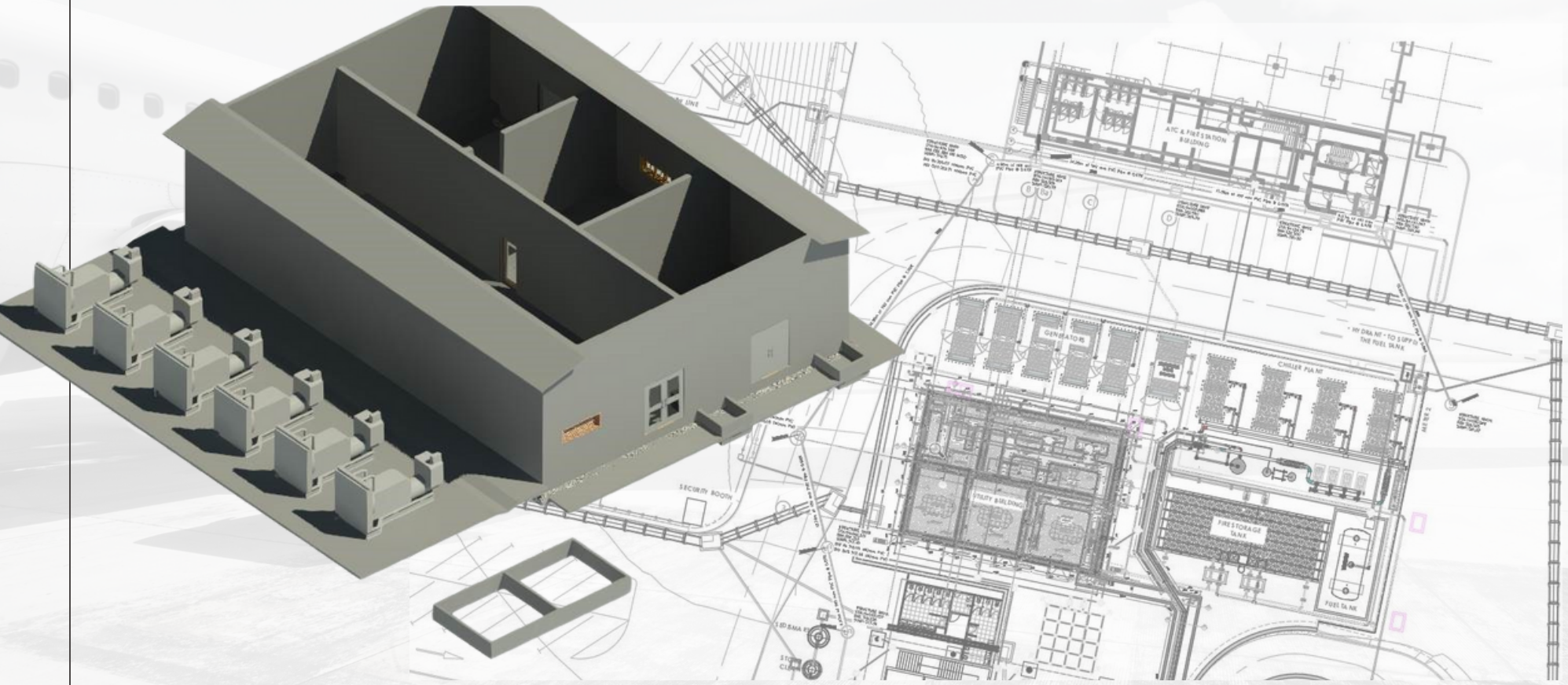
Floor Area increase from Phase II to Phase III:

Description	PHASE II	PHASE III
Level 01 Area	2,840.31m2	3,515.65m2
Level 02 Area	3,340.77m2	4,578.24m2
Mezzanine Level Area	0m2	2650.64m2
Total Area	6,181.08m2	8,744.53m2

MAIN UTILITIES AREA

The main Utilities Area is located adjacent to the new terminal building (north side). The following services are provided in the Utilities Area:

- Main Substation Building;
- Generator Fuel Storage;
- HVAC Area, housing the chiller units;
- Fire Water Storage Tank;
- Fire Water Pump Station (Containerized);;
- Potable Water Storage Tank;
- Potable Water Booster Pump Station (Containerized).



YOUR **AFRICA** ENGINEERING EXPERTS

PROVIDING UNIQUE, INNOVATIVE AND COST-EFFECTIVE ENGINEERING SOLUTIONS SINCE 2010

Nurizon has been built on a solid foundation of three core values – Innovation, Professionalism and Openness. With these fundamentals in place, we have built invaluable trust-relationships with local and international clients, continually providing them with security, comfort and confidence as we continue to deliver quality integrated solutions for their projects.

With many years of combined experience, we are able to assist from the onset to completion of your project, to ensure the finest possible outcome. Our 'beyond boundaries' approach makes us renowned for our adaptability, as we naturally view every project with an element of uniqueness. Consistently maintaining remarkably high standards, we continue to thrive on repeat business, secured by work relationships built on integrity, by applying our core values in every aspect of conducting business.

AFRICA EXPERTS

Having completed numerous successful projects on the African continent over the past decade, with a head office based in South Africa, we understand the challenges in terms of logistics and politics within the African environment.

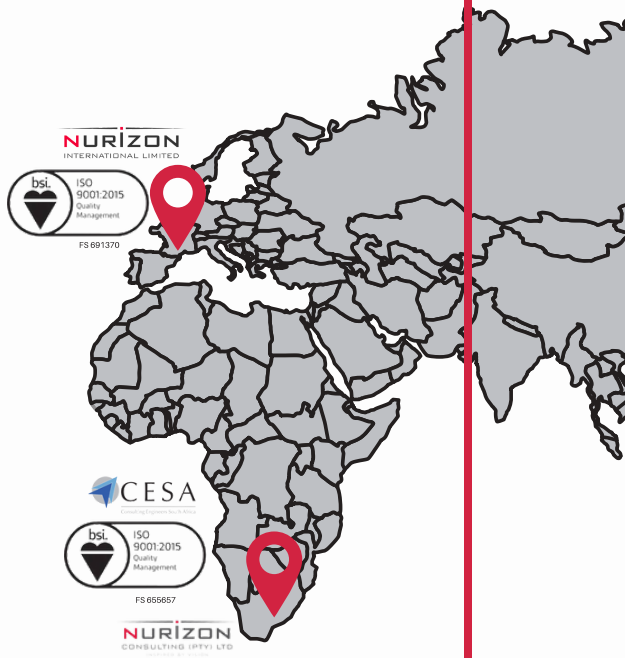
Our Directors and Senior staff members are hands-on from the onset to completion of each project and we pride ourselves on providing quality service.

MULTI-DISCIPLINARY

With our vibrant team of hand-picked engineers and support staff, well experienced in working **in various multidisciplinary engineering environments,** no challenge is too great for the NuTeam to take on!

INTERNATIONAL FOOTPRINT

Our project portfolio is exceptionally varied, with 430+ successfully completed **projects in 24+ different countries** across the African, European and Oceania continents. Our head offices in UK and South Africa provides for easy access to the African and European contents.



WHO WE ARE BY **NUMBERS**

430+ SUCCESSFULLY COMPLETED PROJECTS

ACROSS 24+ DIFFERENT COUNTRIES

10+ YEARS EXPERIENCE

1 VIBRANT, HAND-PICKED, AND EXPERIENCED **NU-TEAM**

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