

# A Probe into Key Points in the Planning and Design of Integrated Corridor at Large Civil Airports

**Qing Zhao<sup>1</sup>**

<sup>1</sup>China Airport Construction Group Corporation, China

cacc\_zhaoqing@sina.cn

**Abstract.** If we compare an airport to our human body, all sorts of specialized pipelines and wires are to an airport as the vascular system and nervous system etc. to the human body, where each functional zone connecting the airport serves each major system of airport and provides “throughput like the function of driving out the processed for the new” and “central control and transmission function”. Guided by the master plan and the concept of progressive development of airports, it is critical to map out a plan to link near-term and long-term development of supporting utilities. The role and effect of integrated corridor is of significance to the construction of multi-runway large-sized new airports or to the expansion of an airport costing tens of billions. In view of the features of the fast growing civil aviation sector in China, this thesis argues for the necessity to plan for and build integrated corridor at large airports, suggests doing research on integrated corridor at the project consulting stage by drawing upon available airport design experiences and case studies and combining the plan for public utilities (or special plan), and analyzes and outlines key points in integrated corridor design based on special requirements and industrial standards for civil airport management.

## 1. Introduction

Along with fast economic growth, the traffic throughput of the civil aviation industry in China has kept growing at a rate 50%-70% higher than the GDP growth rate in the last decade. Large civil airports in China usually reach the designed capacity defined in the prior period three to five years ahead of time. Before expansion, airport equipment and facilities have been overloaded for a long period of time, which has become a bottleneck hindering airport development and airport expansion has been put on the agenda. An airport expansion project usually starts by revising the existing airport master plan and doing preliminary research for project approval etc. The maneuvering area and terminal area are usually the core of any airport expansion project and public utilities form an important part. A big challenge is posed by underground pipelines, which means breaking the existing pavement, digging out a trench and laying pipelines. This imposes significant pressure on safe operation of a civil airport. It is even more costly to break the pavement of continuous roads in the maneuvering area<sup>2</sup> (taxiways and aprons, for example) for laying pipelines, as this will block the taxiways. Is it possible to plan for and build underground pipelines properly at the stage of airport planning and research for project approval? This is a topic heatedly debated among planners and designers.

## 2. Necessity of Integrated Corridor for Airports

<sup>2</sup> Maneuvering Area is the aircraft movement area of an airport.



Around the year of 2008, The Institute of Planning and Design, China Airport Construction Group Corporation (The Institute of CACC) began to address the deployment of integrated corridor in the preliminary work of large airport projects approval. The civil aviation industry now advocates some new airport development concepts, such as Green Airport, Intelligent Airport, and comes up with a new interpretation of Duly Future-proof airports. This inspires planners and designers.

### 2.1. Necessity of Integrated Corridor in the Maneuvering Area

Civil airports built between the late 1980s and the early 1990s mostly feature a pattern of “one runway + terminals + comprehensive supporting area + cargo terminal area + aircraft maintenance area” (see Figure 1). These airports typically have annual passenger throughput of less than 10 million person-times at the beginning, and the border line between the air side and the land side<sup>3</sup> in the maneuvering area is usually parallel to the runway. Energy, water, heat resources and communication needed at the air side are supplied by central substation, water supply station, boiler room and information center in the comprehensive supporting area at the land side. The pipelines at the air side and the land side are independent of each other and some pipes are connected at the border. In other words, few pipelines originate from the land side and cross the maneuvering area.

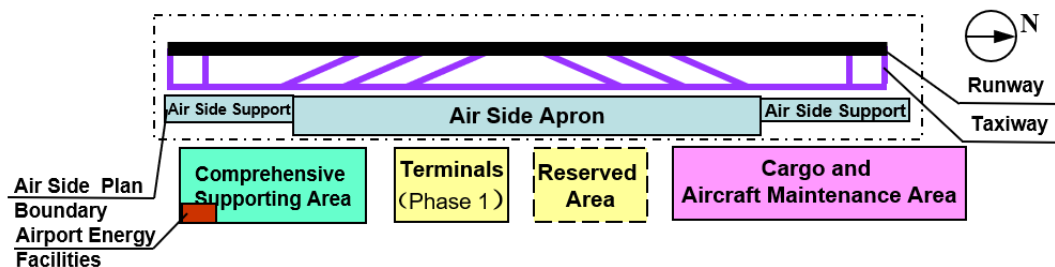


Figure 1. One-Runway Airport Plan

Land side facilities are cut apart into 2 to 3 areas in the north and south by newly built terminal (including air side and land side) facilities and the vertical taxiway link between two runways (see two groups of taxiways running from east to west in Figure 2) when an airport undergoes large-scale expansion and particularly when the second long-distance runway is to be built. The pipelines connecting the south area and the north area need to cross the air side and be covered by widespread pavement in the maneuvering area, making future maintenance and expansion of the pipelines a challenge.

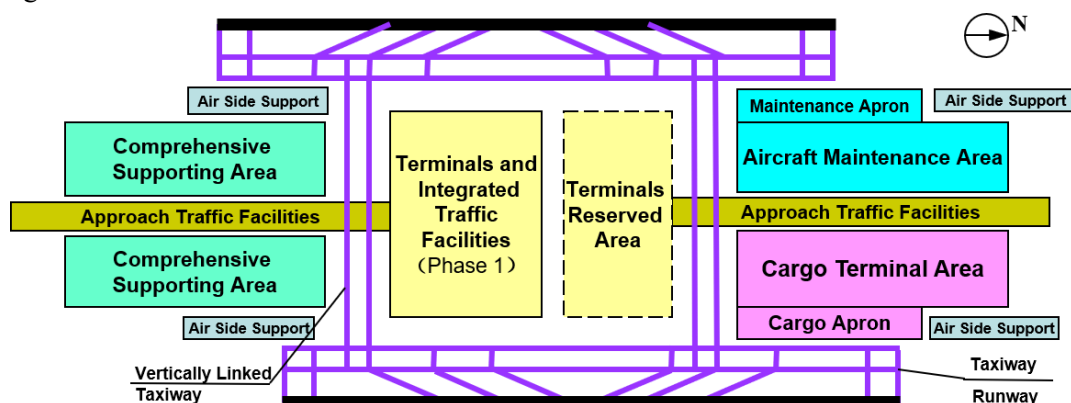


Figure 2. Multi-Runway Airport Plan

<sup>3</sup> Air side and land side are two types of area with airport security as the boundary, among which the air side is the security segregated zone after the security check.

Figure 1 and Figure 2 show the plans of airports at different stages, and illustrate the preliminary location and future development of each functional zone. Public utility pipelines serving the entire airport must connect each functional zone. For this reason, each special pipeline will pass through the vertical taxiway link or the air side and land side of the terminal area. Hence, it is necessary to propose a well-designed solution that is scientific and reasonable at the phase of planning and project approval to minimize the damage to existing pavement and impact on safe operation of aircrafts posed by any future airport pipeline project. Apparently, deploying integrated corridor under the maneuvering area can effectively resolve problems in future pipeline expansion and maintenance. At the phase of project planning, it is necessary to plan for and build underground integrated corridor under the maneuvering area of large airports and reserve space for future pipeline expansion in the integrated corridor, in light of the concept of progressive development of airports by phases.

### *2.2. Necessity of Integrated Corridor in the Comprehensive Supporting Area*

As the comprehensive supporting area is restricted by clearance, ordinary buildings must not be higher than the benchmark clearance of 45.00m. Therefore, it is unlikely to realize the 3.0<sup>4</sup> planned plot ratio of buildings in the comprehensive supporting area. Moreover, due to strict restrictions<sup>5</sup> on the land use plan of airports, the maneuvering area and terminal area combined usually occupy about 70% of total land area used by a large airport. Minus the land allocated to cargo terminal area and aircraft maintenance area, the land available for the land side comprehensive supporting area is very limited. As a result, the layout of the road network and the width of red line boundary have bearing on not only the capacity of net land area available for buildings in the comprehensive supporting area, but also on the width of special pipelines located within the boundary. More than 10 types of special pipelines are present at a large airport and dozens of pipelines are laid under trunk roads. In addition, green belts, for example, trees and shrubs planted on road sides, are also situated within the red line boundary. It is obvious that land available for land side functional zones is precious and space for pipelines is hard to get. In the case of expansion of airport pipelines by phases, it is unsuitable to break ground and dig where pipelines are densely laid. In order to make the best of available land and facilitate the operation maintenance and future expansion of all sorts of pipelines, it is quite necessary to deploy underground integrated corridor where main pipelines are densely distributed in the comprehensive supporting area, change 2D plane space into 3D underground space, so as to enlarge the space available for laying pipelines. At the same time, it is important to reserve space and enabling conditions for future pipeline expansion in the integrated corridor.

### **3. Start from Planning of Integrated Corridor Construction**

At the time of expansion of the Capital Airport in 2002, the Institute of CACC systematically studied the planning and design of integrated corridor, and explored further and subsequently accumulated successful experiences from several large airport development projects. Of course, there is still room for improvement in some design details. Now the Institute of CACC has accumulated extensive experiences in planning and design over the recent more than ten years for engineering practice in airports and is able to present much improved design proposals.

In June 2015, the Ministry of Housing and Urban-Rural Development and General Administration of Quality Supervision, Inspection and Quarantine jointly released Technical Specifications for Urban Integrated Corridor Projects. In November of the same year, 12 municipal design institutes in China attended the First Urban Integrated Corridor Development Summit Forum and Urban Integrated Corridor Demo Project Summit. Experts present contributed advice and solutions to the puzzles faced

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<sup>4</sup> The plot ratio of the comprehensive supporting area at airports situated on plains is usually 2.50. Because of the requirements of the cargo terminal area and aircraft maintenance area, the planned plot ratio falls within the range of 0.8~1.0.

<sup>5</sup> Please refer to *Land Use Indicators for Civil Aviation Airport Projects*, edited by The Civil Aviation Administration of China.

by cities in pipeline development. Many construction and management procedures and specific design issues were addressed, such as construction procedures and standards, priority in planning, simultaneous design of corridor and pipelines, feasibility study on inclusion of gas pipeline in the corridor, fire control and safety examination and approval, operation & maintenance and management system, investment and financing and timing of construction, and information-oriented management. The available literature on the study of urban integrated corridor planning is limited and in particular, information related to civil airport projects is absent.

### *3.1. Key Features of Integrated Corridor*

By summing up last ten years' experience in airport planning and design, we may conclude that integrated corridor has the following features:

- a) Make the most of underground space, and efficiently solve the problem of space shortage for pipelines within the red line boundary;
- b) Apply integrated corridor design, simplify crossing and collision problems of some underground pipelines and make pipeline and road construction procedures more flexible;
- c) Make high-voltage electric wiring in integrated corridor easier;
- d) Reserve space for new pipelines or expansion of existing pipelines in the future, without a need to break the pavement or interrupt the operation of aircrafts and vehicles on the ground;
- e) Make inspection of the pipelines in operation in integrated corridor more intuitive and operation & management with greater ease and minimize the impact on the operation of ground facilities;
- f) Involve huge initial investment for corridor constructions.

### *3.2. Start from Planning Proposal of Integrated Corridor Construction*

An airport development project involves preliminary work as follows:

- a) Master plan of airport—On the basis of forecasts, the runway configuration in the maneuvering area and the capacity of terminal area, among other key issues are determined following research and comparison of several proposals. Meanwhile, the land use plan for functional zones and the entire airport is mapped out and the land used at the current phase is determined;
- b) Project initiation—Project necessity is demonstrated, project proposal is produced and investment is roughly measured;
- c) Feasibility Study—Following feasibility study, an optimal construction plan is produced and investment is estimated;
- d) Regulatory detailed plan—The plans for land side functional zones (including comprehensive supporting area, cargo terminal area and aircraft maintenance area) and airport roads are combined, the layout of functional zones and parameters of each plot are determined, including plot ratio, building density, green coverage and parking facilities;
- e) Public utilities planning<sup>6</sup>—According to the designed capacity of the terminal area and facilities needed by the maneuvering area, as well as energy and resource load required by each plot in the land side functional zones, distribution and supply plant (10kV switch stations and substations) and electric wires, water supply station and pipeline, sewage pipeline (or sewage pump included), rain water pipeline (or rain water pump included), recycled water pipeline (or pressure pump included), boiler room and heat exchange station and heat pipeline, cooling station and pipeline, gas regulator station and pipeline, information center and communication cables, sewage and solid waste treatment facilities are planned for.

The integrated corridor proposal should draw upon the research findings at the previous stage and in particular studies of the regulatory detailed plan and public utilities plan. Where pipelines at the land side are densely distributed and need expansion by phases, a quantitative analysis of available space should be conducted and several corridor routing plans be compared. Then after investment factors and

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<sup>6</sup> Also referred to as power supply, water supply, rain water, sewage, recycled water, heat supply, gas supply and communication plans.

long-term development plan conditions are considered, the best suited corridor routing and section plans are chosen.

To sum up, the planning phase is the right time to start with the integrated corridor proposal, and the regulatory detailed plan and public utilities plan are particularly important. Since the integrated corridor proposal involves project investment, it is necessary to roughly measure or estimate the investment needed at the project initiation and feasibility study phases, to feed into project design phase as groundings of project. However, the integrated corridor proposal is not thoroughly examined at such phases of initiation and feasibility study because of uncertainty of the plan and limitations in the depth of work. As the plan for terminals is not yet finalized, the configuration and size of the corridor are variable, the routing, length and section of the corridor, among other dimensional factors, may be inaccurate, and this leads to inaccuracy of investment estimation. For this reason, designers need to learn from past experiences, fully understand project requirements, allow for redundancy in the draft proposal, verify and calibrate it in the phases of regulatory detailed plan and public utilities plan before delivering an optimal final proposal (see Figure 3, dashed lines indicate the location of integrated corridor).

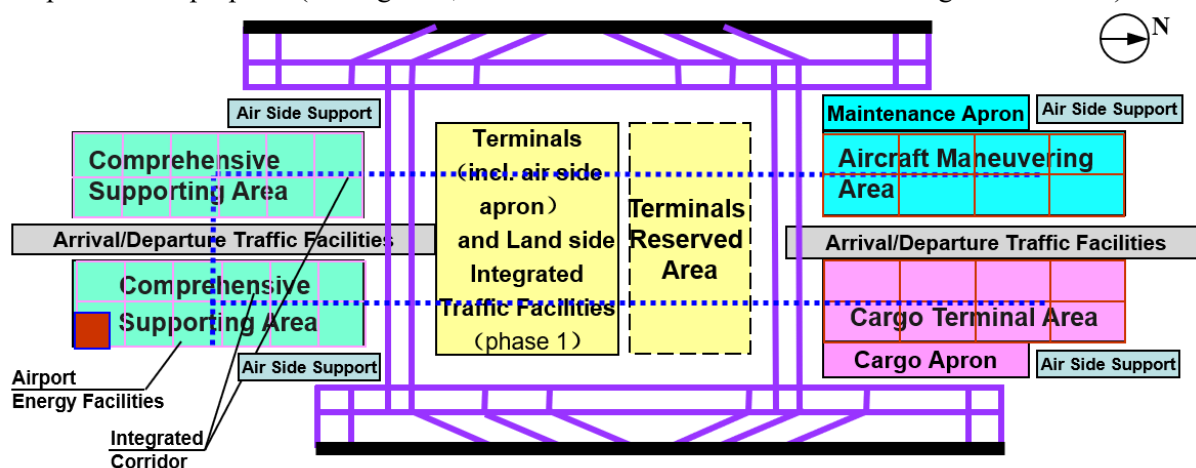


Figure 3. Schematic Plan of Integrated Corridor of Civil Airports

#### 4. Notes on Civil Airport Integrated Corridor Planning and Design

The Institute of CACC systematically studied airport integrated corridor in 2002 when the Capital Airport was expanded. Following studies at the stage of public utilities planning, it proposed a solution to have pipelines pass through the air side of the terminal area and connect the north comprehensive supporting area. In that project, an integrated corridor was built in the maneuvering area, to both solve the routing issue of cooling, heating, water and power supply and communication wiring needed by terminals built at the current phase, and to connect water supply, sewage, power supply and communication pipelines in the north comprehensive supporting area. Meanwhile, space was reserved for expansion of the pipelines. Pipeline laying, operation, maintenance and expansion were made much easier. The project was highly praised by the owner and the integrated corridor proved successful.

The Institute of CACC was successful in integrated corridor design in a number of large airport projects it carried out subsequently, and owing to the sequence in which the abovementioned preliminary work was carried out, there was indeed some deviation in the size of integrated corridor from the plan, and as a result design changes were not avoided and additional construction costs were incurred.

##### 4.1. Differences Between Civil Airport Integrated Corridor and Urban Integrated Corridor

Integrated corridor at an airport is different from that in a city. Technical Specifications for Urban Integrated Corridor Projects recently unveiled jointly by the Ministry of Housing and Urban-Rural Development and General Administration of Quality Supervision, Inspection and Quarantine apply specifically to urban development projects. A civil airport, however, is divided into air side and land side on a floor plan. The airside maneuvering area is an area segregated for airport security, and has



extensive apron and taxiway pavement. According to Technical Standards for the Maneuvering Area of Civil Airports, the maneuvering area has strict restrictions on the location and height of ground obstacles, therefore, the location of the ventilation outlet and height shall comply with the standards aforementioned.

The planning and design experiences of the Institute of CACC is summarized and some noteworthy aspects about the design of airport integrated corridor are outlined below.

#### *4.2. Notes on Land Side Corridor Design*

The conditions of land side planning are similar to those of urban regulatory detailed plan. Integrated corridor design should comply with Technical Specifications for Urban Integrated Corridor Projects and pay attention to these factors:

- a) How pipelines originating from the integrated corridor cross other adjacent pipelines;
- b) Several alternative solutions should be compared and analyzed where the integrated corridor crosses a river or rain water culvert;
- c) The video surveillance monitoring system of integrated corridor is shared with the maneuvering area.

#### *4.3. Notes on Maneuvering Area Corridor Design*

The design of maneuvering area corridor shall comply with industrial standards with reference to Technical Specifications for Urban Integrated Corridor Projects and the following matters deserve attention:

- a) Physical segregation facilities for airport security purpose should be placed where the integrated corridor crosses the enclosure of the maneuvering area and the air side and land side should have separate entrances/exits to the corridor;
- b) The location of ventilation outlets of the integrated corridor should be kept away from the pavement of taxiway and be free from the restriction on conventional intervals between ventilation outlets;
- c) The location and height of ventilation outlets should comply with the restrictions of the maneuvering area on ground-mounted facilities defined in Technical Standards for the Maneuvering Area of Civil Airports;
- d) The horizontal location reserved for feed openings of the integrated corridor should be kept away from the pavement in the maneuvering area;
- e) The mounting pieces of cooling and heating pipelines in the integrated corridor should be synchronous with structural design;
- f) Integrated corridor laid along service roads of the terminal area should be coordinated with the supporting structure of boarding bridges;
- g) Reserved pipelines should have openings reserved for passing through the corridor and the openings should be designed with waterproof sealing accordingly;
- h) Temporary drainage facilities of the integrated corridor should be completed simultaneously, to address permeation and temporary drainage of ground water;
- i) The entrance and exit of the integrated corridor should be designed to prevent inflow of surface water.

### **5. Conclusion sand Suggestions**

This thesis has reached the following conclusion and recommendations regarding the planning and design of integrated corridor of civil airports:

#### *5.1. Conclusion*

To do good to long-term development of civil airports, it is necessary to reserve space for pipeline expansion at the current project, meet the requirements for regular inspection, operation control and safe operation and do well in integrated corridor planning at the preliminary research and planning phases of

large civil airports. Technical Specifications for Urban Integrated Corridor Projects may serve as an applicable code in design phase, while the special requirements of civil airports should be taken into consideration and the technical standards of the industry shall be the prevailing code to be complied with. The integrated corridor should be built simultaneously at the current phase of the project.

### *5.2. Recommendations*

Checkpoints in the management of development of a civil airport include site review, preliminary feasibility study, feasibility study, master plan review and near-term detailed plan. The public utilities plan is not yet included. It is advised to map out the public utilities plan and comprehensive supporting area regulatory detailed plan for large airports simultaneously, and to conduct a topic study on integrated corridor planning by referring to Technical Standards for the Maneuvering Area of Civil Airports and to define pertinent planning principles and design standards.

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