Network Rail

King's Cross Station Enhancements

Assessment of Southern Canopy Options

FINAL

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December 2006

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1 Introduction

This report describes three different design options for weather protection canopies proposed for the Southern Façade at King's Cross station. It describes the options and the key benefits and disbenefits of each. The report also describes the main passenger flow issues in the vicinity of the Southern Façade.

This report is issued as an addendum to the Arup Station Design and Passenger Movements report, issued to Network Rail in December 2006.

At this stage a qualitative rather than quantitative assessment has been undertaken due to timescale constraints. A quantitative modelling assessment would be based on a number of assumptions concerning differing passenger behaviour for each design option which would need to be agreed with Network Rail. These assumptions have already been noted in the assessment of design options described in Section 3 and it is considered that simulation modelling would add no value to the appraisal process.

2 Key Passenger Movements

Figures 1 and 2 show the key passenger movements through King's Cross during the AM peak period, the peak arrivals time. It shows that the Southern Façade will operate as an exit only route, with limited exiting through the Western Range gates. Access to the Main Shed platforms will be through the Western Range gateline. This design and operational specification has evolved through a series of in depth reviews with various stakeholders involving detailed engineering planning and engineering assessments, analysis of rail station operations, and co-ordination with adjacent interchange and development projects.

Over 50% of passengers exiting the Southern Façade are moving towards the LUL Southern Stair, with large flows towards Euston Road for bus connections and other street destinations.

3 Need for Weather Protection

Figure 3 shows the behavioural responses of passengers (confirmed by video surveys at Warren Street station) to wet weather at the limit of dry/covered areas. Passengers exiting the Southern Facade will slow, stop and change direction in order to avoid getting wet and to put on coats/put up umbrellas etc.

This will lead to localised congestion and blocking of key exit routes from the station. A proportion of passengers will also divert through the Western Range gateline to remain dry. There is a high risk that during very bad weather a high proportion of passengers will reroute through the Western Range gateline. This gateline experiences surge movements when trains are called for boarding and so additional egress movements through this area must be avoided to prevent congestion and the breakdown of flow.

Figure 4 shows how passenger egress movements and behaviour can be modified by extending the covered area out from the Southern Facade to cover routes to the LUL Southern Stair and the start of routes into the public realm. An extended canopy enables passengers to move through the gateline and facade in as quick and efficient manner as possible, drawing them away from the gates and narrow arches so they do not block following passengers. A canopy will also encourage passengers to exit through the Southern Facade rather than route through the Western Range gateline.

The modelling assessment described in the Station Design and Passenger Movements report recommends that any canopy should be continuous and extend to the LUL Southern Stair. Therefore all LUL passengers have a dry route when exiting the station.



Figure 1: King's Cross Station Western Concourse Proposed Layout and Key Movements



Figure 2: King's Cross Station South End Key Movements (AM 0700-1000 hours)







Figure 4: King's Cross Station Legion Model Area and Southern Facade

Legion Model Area

4 Assessment of McAslan Canopy Options

John McAslan and Partners have developed three design options presented as **Figures 5**, **6 and 7**. These designs include a mix of smaller, more limited canopies and more continuous covered zones. The benefits and disbenefits of these designed are described in the following sections.

4.1 Design Option 1

This design includes two sets of three limited canopies extending approximately 5.5m out from the Southern Façade as shown in **Figure 5**.

This option has a number of problems/issues and is not considered satisfactory.

The three canopies cover the immediate area in front of the Southern Façade egress archways. However, they do not extend to the LUL Southern Stairs and leave a gap of almost 10m as shown in **Figure 5a**.

During wet weather it is very likely that passengers will gather at the limit of the dry area before 'dashing' to the LUL stairs which will be wet from the rain. This will lead to accumulation and congestion at the western limits of the Southern Facade and a serious safety issue on the LUL Southern Stair with potential for slips and trips as people come in from the wet.

Passengers egressing the Southern Façade and walking east to west (ie towards the Southern Stair) should be continuously covered. Option 1 shows gaps between canopies and so this would disuade east west movements under the proposed canopies. These east-west movements would then be pushed inside the limits of the Southern Facade and into conflict with the gateline run-off. Network Rail Group Guidance Note GI/GN7515, February 2003 page 9, states that configuration of the gatelines should reduce crossflows and that crossflows should occur in 'open' rather than 'confined areas'.

This Network Rail guidance is based on the London Underground Station Planning Standards and Guidelines (SPSG), recognized as a best practice guide for station planning. The SPSG document states that a gateline to passageway run-off of 6m should be planned for in order to give passengers time to orientate themselves and move away from the gates. The existing covered area in the Southern Façade should not be used as a cross passageway and be preserved as a gateline run-off zone.

The disbenefits associated with Option 1 during wet weather are marked on the attached **Figure 5a** and are summarized as follows:

- Passengers will re-route through the Southern Façade using the western most gates in order to stay dry;
- Passengers will wait at the edge of the dry area blocking those following and obstructing the free flow through the Southern Façade (with potentially a few stopped passengers blocking the egress route of a full peak hour train load);
- Passengers are then likely to run from the edge of the dry area, through the rain, to the LUL stair resulting in a safety hazard and potentially slips and trips on the stair;
- Passengers will use the existing covered area to make the east-west movement towards the LUL Southern Stair resulting in passenger flow conflicts in this run-off area; and
- Passengers egressing the Main Shed will re-route from the Southern Façade to the Western Range gateline resulting in peak period conflicts between opposing flows and congestion in this critical area.

Option 1 is therefore not considered acceptable in terms of passenger movement given the interruption and obstruction to passenger egress from the Main Shed, passenger re-routing through the critical Western Range gateline, and the potential for a safety hazard at the LUL Southern Stair.

4.2 Design Option 2

This design options includes two larger canopies extending 6m out from Southern Façade as shown in **Figure 6**.

This situation slightly improves on Option 1 but still has a number of disadvantages and is not considered acceptable in terms of passenger movements.

The disbenefits associated with Option 2 during wet weather are illustrated in **Figure 5a** and are summarized as follows:

- A gap of some 6m exists between the canopies could redirect passengers inside the Southern Façade and into conflict with the gateline run-off zone;
- There is also a gap between the western most canopy and the LUL Southern Stair of some 6m which could result in disrupted passenger flow as passengers wait under the dry canopy to put up umbrellas etc before making the 'dash' to the LUL stair.
- The gap between the western most canopy and the LUL stair represents a slips and trips hazzard;
- Passengers egressing the Main Shed could re-route from the Southern Façade to the Western Range gateline resulting in peak period conflicts between opposing flows and congestion in this critical area.

Option 2 is therefore not considered acceptable in terms of passenger movement for the same reasons as Option 1: The interruption and obstruction to passenger egress from the Main Shed, passenger re-routing through the critical Western Range gateline, and the potential for a safety hazard at the LUL Southern Stair.

4.3 Design Option 3

This option includes two sets of three limited canopies as with Option 1, with an additional canopy set 4m out from the Southern Facade and running the full width of the Main Shed.

This option provides improved weather protection for passengers egressing the Southern Facade. However, the issues associated with Option 1 still remain in that there is still an open area between the canopy edge and the LUL Southern Stair.

Option 3 is considered unacceptable in passenger movement terms as passenger moving towards the LUL Southern Stair are still exposed to wet weather with the risk of slips and trips on the stair.

This option would work better for passengers if the canopy was widened, and extended to cover the LUL southern stair and lift.







Figure 5a: McAslan Southern Canopy Option 1 – Passenger Flow Issues



Figure 6: McAslan Southern Canopy Option 2





5 Canopy Requirements

A weather protective canopy is required on the Southern Façade of the Main Shed in order to enable the station to operate as designed with access to the Main Shed through the Western Range and egress through the Southern Facade.

This operation has been refined through a series of in depth design reviews with key stakeholders as a response to the positioning of the main concourse on the western side of the station with resulting side access. Passenger egress from the Main Shed through the Southern Façade is critical to the effective and safe operation of the station and will require weather protection to draw people through the gateline run-off zone and away from the station.

The canopy must provide complete weather protection and a fully dry route for all passengers exiting the Southern Façade and moving to the LUL Southern Stair and lift.

Only by providing for a completely dry route to the LUL stair will the following issues and risks be mitigated:

- Conflict in the Southern Façade gateline run-off zone;
- Passengers waiting on the edge of the dry areas blocking those following with potentially a full trainload of exiting passengers affected;
- Resultant re-routing of passengers through the critical Western Range gateline; and
- Safety hazards resulting from slips and trips in the wet on the LUL Southern Stair.

6 Dynamic Assessment

The concept and benefits of including a weather proof canopy on the Southern Façade was tested using the Legion pedestrian simulation software. Different scenarios were tested and included a no canopy wet weather option and a canopy option. The scenarios were tested to assess a significant change in passenger behaviour and routing. The results were fully reported in the Station Design and Passenger Movements report, July 2006.

The modelling of passenger behaviour at the edges of the covered areas during wet weather incorporated research at Warren Street where passengers were videoed exiting the station during wet weather.

This modelling assessment concluded that a covered route between the Southern Façade and the LUL Southern Stair was required.

7 Preferred Southern Canopy Option

Following consultation between Network Rail, LUL, English Heritage, Arup and John McAslan and Partners, it has been recognised that the canopy should provide a continuous and completely dry route from the edge of the Southern Façade to the LUL Southern Stair and lift where most passengers are destined. The canopy should therefore extend to the full width of the LUL Southern Stair and lift, some 5.5-6m out from the façade. This distance will also provide enough space for other passengers, moving towards bus stops and Euston Road, to move away from the Southern Façade gateline and enable the gate run-off area to operate effectively.

A canopy has been developed which respects the need for this dry route with drawings produced by John MacAslan and Partners. The design is shown in **Figure 8**.

Figure 8: Proposed Southern Canopy



8 Canopy Width and Rain Protection

The Southern Façade canopy width is some 5.5m out from the edge of the Southern Façade, a distance which covers the full width of the LUL Southern Stair. This is the minimum required to ensure that the full width of the stair is usable by passengers moving out of the Main Shed to LUL. The full width is required given the number and 'surge' nature of passenger flows after train arrival.

There is an additional proposed cover for the LUL stair and lift with side panels to ensure dry conditions. This extends to meet the Southern Façade canopy ensuring a continuous dry route for passengers between the Southern Façade and LUL.

During most wet weather conditions it is considered that rain will not penetrate under the canopy. However, it is recognised that during certain weather conditions the wind may blow the rain towards the Southern Façade with rain penetrating beneath the canopy. The height and width of the canopy is designed to minimise any rain penetration.

Figure 9 shows the extent of rain penetration at an assumed rain angle of 45°. It is considered that this angle represents the most severe conditions. **Figure 10** shows the extent of rain penetration should the angle of rainfall be 35° from the vertical representing less severe conditions.

In both conditions the rain does not penetrate more than 2m beneath the canopy ensuring that most of the route to the LUL Southern Stair is protected and that there is sufficient distance to pull passengers away from the Southern Façade gateline.



Figure 9: Rain Penetration Beneath the Southern Façade Canopy (Rain Angle = 45°)

Figure 10: Rain Penetration Beneath the Southern Façade Canopy (Rain Angle = 35°)



9 Conclusions

The following conclusions can be drawn from this assessment of weather protection offered by the proposed Southern Canopy:

The canopy must provide complete weather protection and a fully dry route for all passengers exiting the Southern Façade and moving to the LUL Southern Stair and lift;

A Canopy should extend to the full width of the LUL Southern Stair and lift in order to ensure protection for LUL passengers during wet weather;

In more severe weather conditions there will be some rain penetration beneath the proposed canopy;

Even during severe weather when the angle of rainfall into the Southern Façade is 45°, the proposed canopy offers passengers sufficient cover to allow dry interchange with LUL; and

The additional covered area built specifically for the LUL Southern Stair and lift will ensure maximum weather protection for interchanging passengers.