Assessment of route and destination displays on public service vehicles. Part 4: conclusions and recommendations.

Part 4

Conclusions

and recommendations

Assessment of route and destination displays on PSVs

PPAD 9/72/5

Part 4
Conclusions and recommendations

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Contents

1.0 Introduction

The previous reports associated with this research project have related to specific areas of research:

- Part one – Research review and industry consultation,
- Part two – Laboratory trials,
- Part three – Field trials.

The aim of this report is to draw conclusions from these findings and develop recommendations.

2.0 Summary of overall findings

Combining the results of the initial background research, the initial laboratory trials and the subsequent field trials, the following aspects have been found.

2.1. Identification as a bus

Discussions with visually impaired groups indicated that actually identifying the approaching vehicle as a bus could be problematic for some. Since this was not directly part of the project specification, it was not investigated further, but it is noted for its relevance to the broader context of this research.

2.2. Identification of the route information

Discussions with visually impaired groups also indicated that having identified an approaching vehicle as a bus, it was sometimes difficult to 'locate' the route information on the front of the bus due to the 'clutter' of advertising and graphics. Since this was not directly part of the project specification, it was not investigated further, but it is noted for its relevance to the broader context of this research.

2.3. Location of display within vehicle

Comments by operators were that modern vehicles are more curvaceous causing the displays to be set further back and so more difficult to read. This was also the opinion of the experimenters in the field trials who considered that the relatively deeper recessing of one display within a vehicle contributed to its poorer angles of readability. The operators suggested that to improve display readability, the displays should be located close to the display window aperture and angled towards the road.

2.4. Amount of information

The findings indicate that for both participant groups the addition of even one intermediate stop significantly increases the reading time of the display information above that of just the route number and final destination.

2.5. Layout of display

Whilst this was not part of the research specification, where possible data was collected on this aspect throughout the project.

The majority of the visually impaired participants expressed a preference for the route number to be to the right of the display whilst for the sighted participants there was no consensus. For the majority of participants in both groups the preferences given were rated as strong to very strong, although this was more pronounced for the visually impaired participants. In addition, where operators expressed a preference for the route number location, it was to the right of the display.

The majority of the participants in both groups also stated a preference for the final destination to be displayed below the route number and the preferences given were rated as moderate to very strong.

2.6. Display technology

The participant trials suggest that in terms of reading static displays, the reading distance of the LED display was significantly greater. (In the laboratory trials this was true for both participant groups, by day and night. In the field trials this was only true for the sighted participants under daytime conditions).

When assessed dynamically it was found that reading distances were significantly reduced for the printed white on black (day and night) and flip-dot displays (day only).

In terms of the forward viewing angle, the printed yellow on black display could be viewed at significantly wider angles than the other technologies. This held for the sighted participants only by day and night.

Participant comments stated that the printed displays were bold and clear and that the Flip-dot and LED displays whilst clear at a distance were difficult to read and lacked clarity close-up.

These aspects are summarised in Table 1.

	Advantages	Disadvantages
Printed White	Clear at distance and close-to	
Printed Yellow	Clear at distance and close-to Can be read at significantly broader angles of view	
Flip-dot	Clear at distance	Lack of clarity close-to
LED	Can be viewed at greater distances Clear at distance High contrast	Lack of clarity close-to Poor angularity

Table 1: Summary of display technology advantages and disadvantages

2.7. Display colour

Within the laboratory trials, the visually impaired participants read white text on a black background significantly more quickly than fluorescent yellow text on a black background. No preference was found between yellow text on a black background and black text on a yellow background.

Within the field trials, the fluorescent yellow text could be read at greater viewing angles than the white text.

2.8. Font size

Table 2 below compares the performance of the printed yellow on black display in both the laboratory and field trials.

Route number (Character height 200mm)						
Participants able to read display	95%		50%		25%	
Participant group	NVI	VI	NVI	VI	NVI	VI
Reading distance – Lab (m)	40	3	63	27	71	46
Reading distance – Field (m)	66	4	113	17	131	40
Final destination (Character height 125mm)						
Participants able to read display	95%		50%		25%	
Participant group	NVI	VI	NVI	VI	NVI	VI
Reading distance – Lab (m)	22	3	50	18	66	36
Reading distance – Field (m)	54	2	73	8	91	17

Table 2: Comparison of the performance of the printed yellow on black displays in the laboratory and field trials

The differences in the viewing distances between the laboratory trials and the field trials is considered to be due to a variety of factors including:

- Differing font styles – The font style used within the field trials was a more favourable design since it was more square-like in its formation and so may account for the sighted participants achieving greater reading distances in the field trials,

- Differing visual impairments – the differing range of visual impairments used within the field trials may account for the reduced reading distances achieved in the field trials.

Route number

Using the worst case figures for both groups in the above table, it can be calculated that:

- For 95% of the visually impaired passengers to achieve the reading distance of the sighted participants, character height would need to be increased by a factor of 13.3 (40/3) to 2,666mm,
- For 50%, the character height would need to be increased by a factor of 3.7 (63/17) to 741mm,
- for 25%, the character height would need to be increased by a factor of 1.8 (71/40) to 355mm.

Final destination

Using the worst case figures in the above table, it can be calculated that:

- For 95% of the visually impaired passengers to achieve the reading distance of the sighted participants, character height would need to be increased by a factor of 11 (22/2) to 1,375mm,
- For 50%, the character height would need to be increased by a factor of 6.25 (50/8) to 781mm,
- For 25%, the character height would need to be increased by a factor of 3.88 (66/17) to 485mm.

In addition, height increases described above would need to be further increased to compensate for reduced dynamic reading distances compared to static reading distances. Refer to section 2.6.

2.9. Typeface

Within the laboratory trials, it was found that:

- Bold, broad characters can be read significantly more quickly. This was true for both the visually impaired and sighted participants.
- Normal text can be read at greater distances than condensed text and text with raised descenders. This was true for both the visually impaired and sighted participants.

2.10. Ageing of displays

Due to difficulties in defining an aged system and knowing its relevance to the real world, the ageing of displays was assessed within the laboratory trials with respect to the reduced contrast due to the accumulation of dirt. The LED display had the highest contrast level, followed by the printed yellow on black display and then the flip-dot display. This was reflected in the results that showed that the LED displays (and printed displays for intermediaries only) could withstand equivalent or significantly greater levels of contrast reduction than the other technologies before becoming unreadable. It was concluded that the readability of higher contrast displays would not be affected as quickly by dirt as lower contrast displays.

2.11. Variation in day and night timelighting conditions

This variable was taken into account in the assessment conditions and is reported within the other findings.

2.12. Displays lit and unlit

Through discussions with operators it was established that the displays are always operated lit both daytime and night-time.

2.13. Passenger perceptions

Identification of bus

Both groups of participants primarily use vehicle size and colour as a cue to whether or not the approaching vehicle is a bus followed by the presence of a route number on it.

Relative importance of displays

The front display was found to be significantly more important to the use of the bus by both groups of participants and the side display was found to be more important to visually impaired participants than the sighted participants.

Display readability

In both the laboratory and field trials, the majority of the sighted participants rated the display readability favourably, whereas a half or less of the visually impaired participants gave such ratings thus indicating the difficulty for the latter group in reading bus displays generally.

Display element

The route number was found to be significantly more important to the use of the bus by both groups of participants.

Favourable features of display design

Based on the laboratory and field trials it was found that both participant groups asserted that large print followed by well lit displays assisted their use of the display. In addition they stated that good design features were clear/large numbers, large destinations, bold lettering with clear fonts, high contrast and the use of yellow on black (favoured by the visually impaired participants only).

Unfavourable features of display design

Features, cited by both participant groups, which made the displays difficult to read were the number being too small, followed by glare and reflection. Additionally the visually impaired participants stated presence of the sun and information misalignment as problematic.

Improvements

For both participant groups, larger numbers was the most frequently cited method of improving bus displays in the future. In general, the results of both the laboratory and field trials indicated that the visually impaired participants favoured improved clarity whilst the sighted were more concerned with the type of information provided.

Technology

Subjectively the printed displays had more favourable comments. Whilst the LED display was commented on as being bright at night, it was, like the flip-dot display considered to be difficult to read close up. Additionally the LED suffered from problems with angularity.

2.14. Practicality of system operation

Fleet flexibility

The primary difference between the printed and Flip-dot/LED display systems is that printed displays are used within vehicles that are dedicated to a route whilst the flip-dot/LED displays enable vehicles to be used flexibly across routes. For printed displays, the route(s) that a bus will cover are identified and the relevant destinations incorporated within a printed blind. When a driver is allocated to a route, only those vehicles with the appropriate place names on its blind will be available for use. For the flip-dot/LED displays, when a driver is allocated to a route any vehicle is available for use since the destinations are downloaded into the bus's display system. The flip-dot/LED displays therefore offer greater flexibility to the operator across their vehicle fleet enabling them to be more responsive to demands arising on the vehicles.

Additional displays

If a new display is needed, for instance due to a change in a route, for the flip-dot and LED displays this requires the electronic system to be re-programmed; a procedure that can be undertaken relatively simply in-house. For the printed displays, a new blind (or part of a blind which will be inserted within an existing blind) needs to be made. Whilst traditionally this was undertaken in-house, it is now carried out by external, specialist organisations over a few days.

2.15. Ease of setting

Printed blinds - Manual

For these displays the driver has to engage a handle into the blind driving mechanism and manually turn the blind to the required display. Mirrors are positioned to provide visual confirmation that the correct display is showing, this sometimes requires the adoption of awkward postures as drivers strain to view the mirror images. If the blinds have a large number of displays on them, this can be a time-consuming task. In addition, it can require the driver to apply high forces in order to turn the displays, particularly if the turning mechanisms have deteriorated.

This procedure has to be undertaken for each of the front, side and rear displays thus adding time to the display changing process. Also, since the driver has to leave their cab to change the side and rear displays, the process does reduce the personal safety of the driver and the security of the vehicle.

Printed blinds – Power-driven, Flip-dot and LED

For these displays the driver uses a data entry keypad, located within the cab, to select the required destination information that is then automatically displayed by the system. This requires minimal effort on the part of the driver, since the system is push button operated, and all three displays are simultaneously updated.

2.16. Reliability of equipment

Printed displays

This is the oldest of the display technologies and only in recent years have printed displays had the provision to be power driven displays opposed to manually operated. For the manual systems, the reliability is dependent upon the smooth functioning of the mechanism for which relatively labour intensive maintenance is required. As the mechanisms wear, the system operation deteriorates causing the blinds to become over wound, twisted or torn with the potential for the mechanism to seize completely. The mechanical parts require replacement every five years, although they may last as long as 15.

Flip-dot displays

These displays have been on the market for about 10 years. Their reliability is considered to be better than printed displays; with some manufacturers offering a lifetime guarantee. These systems are maintenance free although some cleaning is usually undertaken which is more difficult than for a printed system.

LED displays

LED displays have only become available in the last five years and are considered to be more reliable than both the printed and flip-dot systems. Generally the maintenance required is low consisting of cleaning and LED replacement.

2.17. Reliability of information displayed

Printed displays

A problem with the manual printed displays, which was mentioned by operators and trials participants, was that the destination information could become misaligned within the display aperture making the reading of some elements difficult. Problems with the mechanisms can make the blinds droop or become twisted. Twisted blinds can expose light to the side of the display that can be confused with the illuminated characters on the display. In addition because the printed systems are not sealed, they are more prone to dirt ingress that can cause degrading of the text.

Flip-dot displays

The reliability of the information displayed using this technology has improved over the decade of its use. Although some dots may stick and fade, some manufacturers do offer a lifetime guarantee for the performance of their systems. The reliability of the information displayed may also be affected by the generally poorer character clarity and viewing the displays in low light conditions.

LED displays

Like the flip-dot displays, the reliability of the information displayed using LED technology is affected by the reduced character definition compared to the printed displays. The LED systems can also be difficult to see in bright light conditions, sometimes resulting in ghost images. One manufacturer has developed an adaptation to their LED displays to mitigate against this affect.

3.0 Recommendations

3.1. Identification as a bus

Whilst vehicle colour and size were the most frequently mentioned methods for identifying a bus, the lack of standardised colouring due to deregulation and the ongoing amendments to corporate liveries as well as the confusability of buses with other large vehicles, meant that this was not a reliable strategy for use by the visually impaired passengers. This suggests that the use of a unique identifying feature that can be applied across all PSVs should be considered e.g. a broad fluorescent yellow horizontal band across the front of the bus.

3.2. Identification of the route information

It is recommended that advertising and graphics be removed from the areas of the display and replaced with a format which will not detract form the route information and preferably enhance it e.g. locating the display within the broad fluorescent horizontal yellow band described in 3.1 above.

3.3. Location of display within vehicle

It is recommended that the displays are located immediately behind the display window aperture.

3.4. Amount of information

The route number was considered to be the most important type of information contained within the front display, followed by the final destination and then the intermediates. It was also found the addition of one or more intermediates significantly increased the reading time of the display above that required for reading just the route number and final destination. It is therefore recommended that intermediates only be used where they do not detract from the optimum provision of the route number and final destination information. Refer to 3.8.

3.5. Layout of display

Where preferences were expressed it was for the route number to be to the right of the display and for the final destination to be displayed below the route number.

However it was noted by the experimenters that for deeply recessed displays, the right-hand side of the display might be obscured from the view of passengers standing on the kerbside at the front of the bus. Refer to section 3.3.

3.6. Display technology

It is recommended that the clarity of the flip-dot and LED displays be improved when viewed close up and that the viewing angularity of the LED displays be increased. However the level of increase for these aspects that is ‘good enough’ is not known.

3.7. Colour

It is recommended that displays be used in which the text has a high colour contrast with the background.

3.8. Font size

It is recommended that priority be given to making the height of the route number be as large as possible followed by the character height of the final destination.

3.9. Typeface

It is recommended that bold, broad character typeface that employs conventional dropped descenders (opposed to raised descenders) be used.

3.10. Ageing of displays

It is recommended that displays with a high luminance contrast be used.

3.11. Variation in day and night time lighting conditions

This variable was taken into account in the assessment conditions and is reported within the other findings.

3.12. Displays lit and unlit

Through discussions with operators the displays are always operated lit both daytime and night-time.

3.13. Passenger perceptions

Identification of bus

Refer to section 3.1.

Relative importance of displays

There would appear to be merit to having displays to the front, side and rear and their continued use is recommended.

Display readability

Based on the visually impaired participants used within this research, there is a need to improve display readability. Means for achieving this are given within this recommendations section.

Display element

The route number is the key element in display use. Aspects to improve its readability should be prioritised.

Favourable features of display design

Large, clear, bold high contrast text should be used.

Unfavourable features of display design

Glare, reflection and the misalignment of information should be addressed by the display design.

Improvements

Larger numbers should be used. Refer to section 3.8.

Technology

Refer to section 3.6.

4.0 Implications for display hardware

4.1. Identification as a bus

The findings relating to this are not applicable to display hardware.

4.2. Identification of the route information

The findings relating to this are not applicable to display hardware.

4.3. Location of display within vehicle

It is currently not possible on some vehicles to locate the display directly behind the display window aperture due to the curved nature of the front of the vehicle. To overcome this, either the design of the front of the vehicle must change to accommodate current display designs or the display design must change to accommodate the form of the vehicle. In line with the latter option, at least one manufacturer has developed a display that tries to follow the front curvature of the vehicle more closely than conventional displays.

4.4. Amount of information

The recommendation that intermediates only be used where they do not detract from the optimum provision of the route number and final destination information does not have major implications for the display hardware since most currently have the potential to accommodate intermediates.

4.5. Layout of display

Recommendations relating to the layout of the information do not have major implications for the display hardware since most displays can currently be manufactured or programmed in a variety of configurations.

4.6. Display technology

The recommendations given are requirements for all technologies. Refer to the other headings within this section for the display hardware implications. In addition it was recommended that the clarity of the flip-dot and LED displays be improved when viewed close up and that the viewing angularity of the LED displays be increased. However since the extent to which the clarity and angle of view has to be increased is not known, the precise implications for the display hardware cannot be evaluated.

4.7. Display colour

The recommendation that displays be used in which the text has a high colour contrast with the background is currently being met by most technologies.

4.8. Font size

It is recommended that priority be given to making the height of the route number be as large as possible followed by the character height of the final destination. Since the space available for the front displays on both single and double deck vehicles is limited, there is little opportunity within current vehicle designs to increase font size by increasing the size of the display. Benefits may best be gained from improved use of the existing size of display.

The use of variable messages on LED and Flip dot technologies offers a means to enlarge font size without reducing the amount of information presented. However the practicalities of employing this method and the effectiveness and ease of use by people with visual impairments requires further consideration and is beyond the scope of this project.

4.9. Typeface

The recommendation that a bold, broad character typeface that employs conventional dropped descenders (opposed to raised descenders) be used should be achievable for most display technologies.

4.10. Ageing of displays

The recommendation that displays with a high luminance contrast be used is met by LED displays, although the printed and flip-dot displays may benefit from improvements to their luminous output. Since the optimum luminance levels for displays were not identified within the programme, the precise nature of further system requirements cannot therefore be defined although it is anticipated some additional hardware and power requirements will be required.

4.11. Variation in day and night time lighting conditions

This variable was taken into account in the assessment conditions and is reported within the other recommendations.

4.12. Displays lit and unlit

Through discussions with operators the displays are always operated lit both daytime and night-time.

4.13. Glare and reflection

Methods for reducing the affects of glare and reflection need to be identified and evaluated. Possible methods may include the:

- application of anti-reflective coatings to the display casing and the vehicle's display window aperture,
- use of shielding to shade the display,

- automatic adjustment of display intensity to the ambient lighting conditions,
- forward tilting of the display.

4.14. Display misalignment

Display misalignment is predominantly eliminated through the use of electronic systems and is therefore mainly a feature of manually- adjusted printed displays. Investigations should be made to identify the causes for these misalignments in order to determine if they are related to display, vehicle or driver training factors.

5.0 Cost benefits

The following table reads horizontally across two pages, reading Display Aspect, Problems, Benefit, Solution and Cost.

Display aspect	Problem	Benefit	Solution
Location of display within vehicle	Displays that are recessed due to curved PSV fronts are difficult to read.	Improved reading clarity and reading angle.	Re-profile the PSV front so that it is no longer curved but flat.
			Re-design displays to follow profile of PSV front.
Amount of information	Refer to character height.		
Display layout	Non-standardised layouts are confusing to some passengers.	Improved ease of reading.	Standardise layouts.
Display technology	Dot matrix displays can be difficult to read due to reduced clarity compared to printed displays.	Improve clarity.	Improve resolution.
		Improve clarity.	Improve angularity.
Colour	Low contrast displays are difficult to read.	Improved ease of reading.	Use font colours that have high contrast with background.

Costs		
Printed	**Flip-dot**	**LED**
Such a change would need to be incorporated within the initial design phase of the vehicle but may not be adopted if the reduced profiling increases operating costs. No costs estimates given.		
It is not possible to curve a printed display. For any roller to revolve it must be straight and square.	Unknown.	Not necessarily more expensive. Some manufacturers have already introduced a display that curves to follow the shape of the display.
Refer to character height.		
Since this concerns the re-arrangement of the information in the display, rather than amendments to it, associated financial costs are likely to be negligible.		
Not applicable.	Possible to double the resolution of current displays. (Cost information was not provided)	Possible to double the resolution of current displays. Estimated that this will triple the cost of a standard LED display.
Not applicable.	Not applicable.	
Fluorescent yellow and white provide good contrast and are currently in use; therefore there is no associated on-cost of this benefit.	Fluorescent yellow provides good contrast and are currently in use; therefore there is no associated on-cost of this benefit.	Different colours available. Amber provides good contrast and are currently in use; therefore there is no associated on-cost of this benefit.

Display aspect	Problem	Benefit	Solution
Font size	Fonts are too small for some passengers to read.	Improved ease of reading.	Make displays bigger.
			Increase size of display aperture.
			Maximise height of information within display. (Route number is the priority).
Type face	Some type faces and styles are difficult to read.	Improved ease of reading.	Use square-like characters with dropped descenders.
Ageing of displays	Dirt egress reduces display contrast making displays difficult to read.	Improved ease of reading.	Improve contrast through colour.

<table>
<tr><th colspan="3">Costs</th></tr>
<tr><th>Printed</th><th>Flip-dot</th><th>LED</th></tr>
<tr><td colspan="3">Incorporating recommended character height and width results in a display of 2880 mm by 678 mm. This is beyond the size available on most PSVs. The displays should be made as large as possible.</td></tr>
<tr><td colspan="3">Since this concerns the re-arrangement of the information in the display, rather than amendments to it, associated financial costs are likely to be negligible.</td></tr>
<tr><td colspan="3">Opportunity costs concerning the resultant loss in space available to display other information.</td></tr>
<tr><td>No financial cost.</td><td>Can reduce opportunity cost by increasing resolution. Possible to double the resolution of current displays.
(Cost information was not provided)</td><td>Can reduce opportunity cost by increasing resolution. Possible to double the resolution of current displays. Estimated that this will triple the cost of a standard LED display.</td></tr>
<tr><td>Refer to colour above.</td><td>Refer to colour above.</td><td>Refer to colour above.</td></tr>
</table>

Display aspect	Problem	Benefit	Solution
			Improve contrast through illumination.
Variation in ambient lighting conditions	Under some ambient lighting conditions displays can be difficult to read.	Improved ease of reading.	Employ adjustable contrast within display.
Lit and unlit displays	Refer to variation in ambient lighting above.		
Glare and reflection	Glare and reflection reduce display contrast making displays difficult to read.	Improved ease of reading.	Improve contrast through colour.
			Improve contrast through illumination.

Costs		
Printed	**Flip-dot**	**LED**
It is envisaged that it is not difficult or expensive to improve the lighting on displays. The positioning and the number of tubes used will greatly affect the illumination. Improvement in illumination – negligible costs.	It is envisaged that it is not difficult or expensive to improve the lighting on displays. Improvement in illumination – negligible costs.	Estimated 5% increase in cost of a sign.
Fluorescent lighting is currently used to illuminate most printed blinds. This type of lighting cannot be controlled.	Unknown.	Already implemented by some manufacturers. Estimated minimal increase of £5 per display.
Refer to variation in ambient lighting above.		
Refer to colour above.	Refer to colour above.	Refer to colour above.
Refer to ageing of displays above.	Refer to ageing of displays above.	Refer to ageing of displays above.

Display aspect	Problem	Benefit	Solution
			Apply anti-reflective coatings to display casing and vehicle's display window aperture.
			Forward tilting of the display.
Display misalignment	Misalignment problems make display difficult to read.	Improved ease of reading.	Use power driven displays.

Costs		
Printed	**Flip-dot**	**LED**
Already produce destination blinds using matt coatings and inks to reduce reflection, therefore no extra cost would be incurred. However anti-reflective coating could be placed on bus aperture window. Costs of this are unknown.	Anti-reflective coating could be applied to display screen. Estimated cost £50. In addition anti-reflective coating could be placed on bus aperture window. Costs of this are unknown.	Anti-reflective coating could be applied to display screen. Estimated cost £50. In addition anti-reflective coating could be placed on bus aperture window. Costs of this are unknown.
Such a change would need to be incorporated within the initial design phase of the vehicle but may not be adopted if the reduced profiling increases operating costs. No cost estimate given.		
Power driven blinds are available that minimise this problem. They are more expensive than manually wound roller blinds but less expensive than LED displays.	These displays are power driven and so do not exhibit this problem.	These displays are power driven and so do not exhibit this problem.

6.0 Amendments to regulations

6.1. Identification as a bus

An amendment is required to specify a unique, standardised vehicle identifier to be applied to all PSVs. The nature of the identifier is yet to be defined. Refer to 7.1.

6.2. Identification of the route information

An amendment is required to define a means for assisting passengers in locating the route information on the front of a PSV. The nature of the assistance is yet to be defined. Refer to 7.2.

6.3. Location of display within vehicle

It is recommended that the displays are located immediately behind the display window aperture.

6.4. Amount of information

Intermediate place names should only be used where they do not detract from the optimum provision of the route number and final destination information.

6.5. Layout of display

An amendment is required to define a standardised layout for the route information within the front display. The layout formation requires confirmation. Refer to section 7.4.

6.6. Display technology

The display technology should be appropriate to the viewing distances and angles that the passengers are likely to encounter. This needs to be considered for front, side and rear displays.

6.7. Colour

It is recommended that displays with a high colour contrast between the text and the background be used.

6.8. Font size

It is recommended that priority be given to making the height of the route number be as large as possible followed by the character height of the final destination.

6.9. Typeface

It is recommended that bold, broad character typeface be used. Dropped, opposed to raised, descenders should be used.

6.10. Ageing of displays

It is recommended that displays with a high luminance contrast between the text and the background be used.

6.11. Variation in day and night time lighting conditions

This variable was taken into account in the assessment conditions and is reported within the other findings.

6.12. Displays lit and unlit

Through discussions with operators the displays are always operated lit both daytime and night-time.

6.13. Glare and reflection

It is recommended that glare, reflection and the misalignment of information should be addressed by the display design.

7.0 Further research

7.1. Identification as a bus

A unique, standardised vehicle identifier to be applied to all PSVs has been identified of potential benefit to visually impaired passengers. The form of this identifier should be investigated bearing in mind the needs of both the passengers and the operators.

7.2. Identification of the route information

A means for assisting the passengers in locating the route information on the front of a PSV should be investigated. The form of this identifier should consider the needs of both passengers and operators.

7.3. Location of displays

Within the review of operators it was suggested that the displays should be angled towards the road to improve their readability. The benefits of angled displays should be investigated and the optimum angle identified.

7.4. Layout of display

Further research is required to confirm the layout preferences identified within this research.

7.5. Display technology

Further research is required to identify acceptable levels for the:

- clarity for the flip-dot and LED displays when viewed close to,
- angularity of the LED displays.

7.6. Font size

Further research is required to identify trade-offs in the recommendations to maximise character height and retain a square-like character formation. Under certain conditions, it may not be possible to achieve both of these requirements and guidance is needed to identify the extent to which one can be traded for the other.

7.7. Glare and reflection

Further research is required to identify methods for reducing the affects of glare and reflection.

7.8. Display misalignment

Further research is required to identify the causes for the misalignments of manually operated printed displays in order to determine if they are related to display, vehicle or driver training factors.