



Research Programme

Engineering

Improvements to safety signage on passenger trains
Guidelines for symbol design and testing



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Guidelines for symbol design and testing



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Issue record

This Guidance Note will be updated when necessary by distribution of a complete replacement.

Amended or additional parts of revised pages will be marked by a vertical black line in the adjacent margin.

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1	A	April 2002	Review version
1	B	April 2003	First formal issue

Status of this report

This report has been commissioned by Rail Safety and Standards Board as part of the Railway Safety Research Programme and produced by Interfleet Technology Ltd and Davis Associates Ltd.

The findings, conclusions and recommendations contained in the report are those of Interfleet Technology Ltd and Davis Associates Ltd.

Rail Safety and Standards Boards, on behalf of the rail industry, is currently considering the report's conclusions and recommendations, and what action needs to be taken as a result. A formal response will be issued shortly.

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Contents

Approvals and authorisation Issue record	2
Status of this report	3
Contents	4
1 Introduction	5
2 Definition of terms	6
3 Sign categories	7
4 Process overview	8
5 Stage 1: Generation of symbol variants	9
6 Stage 2: Comprehensibility judgement test	12
7 Stage 3: Comprehension test	17
8 Stage 4: Mutual confusion test	26
Appendices	29

1 Introduction

1.1 About the guidelines

This document presents guidelines for the design and testing of new symbols for use in a standardised system of luminous safety signage for use on board trains in Great Britain.

The guidelines have been produced as part of research project commissioned by Rail Safety and Standards Board (RSSB) (previously known as Railway Safety) on behalf of the Association of Train Operating Companies (ATOC).

The research seeks to satisfy the following recommendations of Lord Cullen's report following the Ladbroke Grove rail inquiry:

- All safety signs shall use luminous material.
- All safety signs shall be capable of being understood without the need to read text (so far as is feasible).
- There shall be a system of signage which is common to all trains in Great Britain.

The guidelines are drawn from industry best practice, from existing standards, and from the findings of specially commissioned research.

1.2 Objective

The objective of the guidelines are:

- to enable the design and testing of new symbols which are legible and comprehensible;
- to enable generation of appropriate evidence to support the symbol approvals process.

1.3 Scope

1.3.1 Categories of signs

These guidelines are applicable to symbols for the following safety sign categories for use on-board trains:

- Safe condition signs
- Fire equipment signs
- Passenger alarm / communication signs

The guidelines do not cover symbols for:

- Mandatory signs
- Prohibition signs
- Hazard warning signs
- General information signs

1.3.2 Implementation process

This document provides the guidelines for the design and testing of symbols. The document does not cover:

- The process for identifying the need for a new symbol or for defining the referent which it must represent.
- The guidelines for combining symbols into safety signs. (These are defined in ITL/GN0001)

1.4 Prerequisites

These guidelines shall be implemented by one or more individuals with the following as a minimum:

- human factors or user research competence,
- graphic design competence,
- technical knowledge of the associated emergency devices/ equipment, as well as the operational context in which they will be used.

The symbol artwork shall be prepared using a suitable vector drawing package such as: Adobe Illustrator or Macromedia Freehand.

2 Definition of terms

The following terms are used in this manual.

Categories of signs: This document covers the development of symbols for three categories of safety signs: safe condition signs, fire equipment signs and passenger alarm / communication device signs.

Comprehensibility judgement test: Procedure for estimating the degree of understanding of graphic symbols. Used to shortlist up to three variants for comprehension testing.

Comprehension test: Procedure for quantifying the degree of understanding of graphic symbols.

Critical detail: An essential graphic element of a symbol, the absence of which would compromise comprehensibility.

Excluded function: Function of a referent, or of a complementary referent, which is not to be denoted by the graphical symbol (e.g. bath should not indicate “shower” or swimming pools”).

Graphic symbol: A visually perceptible figure with a particular meaning used to transmit information independently of text or language.

Graphic symbol tile: The square area enclosing the border and the graphic elements of a symbol.

Image content: The graphic elements within a symbol that convey meaning.

Instruction comprehension test in context: Procedure for assessing the understanding of proposed instruction graphic symbols, when contained within an instruction sequence and within the context of a real vehicle or accurate mock-up.

Luminous material: A material that emits light after a period of being energised by a light source and after the light source has been removed.

Maximum graphics area: The area limiting the graphical elements of a symbol - defined by a border of 8% of tile size.

Mutual confusion test: Procedure to identify potential confusions between the meanings of graphic symbols.

Referent: The subject, idea or meaning that a graphic symbol represents.

Referent field of application: A written description and/or photographic representation of the environment and context of use in which the graphic symbol will appear.

Referent function: A written description of the function associated with a particular referent and/or symbol.

Referent type: Two types of referents are referred to: (i) instructions, and (ii) object / equipment.

Safe condition sign: A safety sign that indicates a safety action, the location of safety equipment or a safety facility, or an escape route.

Safety sign: A configuration of visual elements (e.g. symbols and text) intended to convey a safety-related message.

Variant: One of a number of alternative graphic symbols contending to represent a given referent.

3 Sign categories

This document covers the development of symbols for the following sign categories (ref BS 5499-1):

3.1 Safe condition

Signs shall indicate any of the following:

- An escape route
- The location of the safety equipment or facility
- Operational instructions

Colour specification

Safety colour: Green (BS 5252 ref: 14 E 53)
 Contrast colour: White*

Symbol example:



SYM-B001-GRN

First aid box

(Derived from BS symbol)

3.2 Fire equipment

Signs shall indicate any of the following:

- The location of the fire equipment
- The type of fire equipment.

Colour specification

Safety colour: Red (BS 5252 ref: 04 E 53)
 Contrast colour: White*

Symbol example:



SYM-B005-RED

Fire extinguisher

(Derived from BS symbol)

3.3 Passenger alarm / communication devices

Signs shall indicate any of the following:

- The location of the passenger alarm or communication device.
- Operational instructions

Colour specification

Safety colour: Red (BS 5252 ref: 04 E 53)
 Contrast colour: White*

Symbol example:



SYM-B006-RED

Alarm (including passenger communication device)

(* Or as close to white as possible, given that most luminous material appears off-white.)

4 Process overview

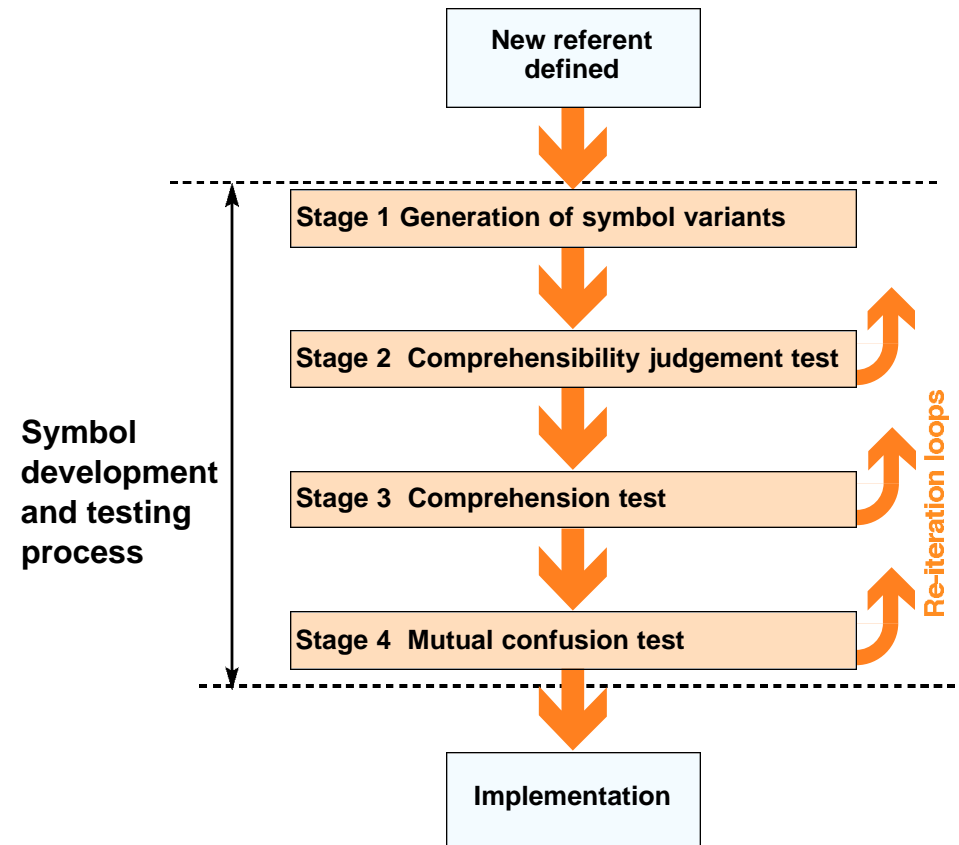
4.1 Overview

Symbols for use in safety signs shall be developed according to the process described in this document. An overview of the process is shown here.

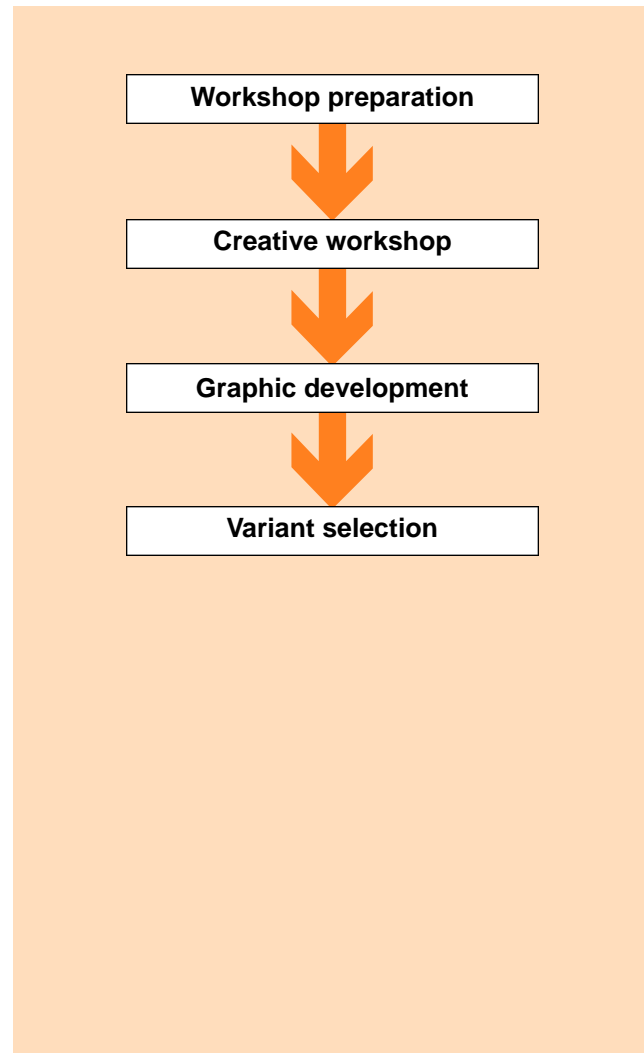
4.2 Preceding stage - definition of a new referent

The process described in this document commences once the need for a new symbol has been identified and once the new referent has been defined in the following terms:

- Referent name:* The name summarising the subject, idea or meaning that a graphic symbol is to represent. (e.g. "Pull doors apart")
- Field of application:* A written description and photographic representation of the environment in which the graphic symbol will appear. (e.g. "on board a rail vehicle next to the doors", and a photograph of the doors would be provided)
- Referent function:* A written description of the function associated with the referent. (e.g. to instruct the passenger to pull the doors apart as part of an instruction sequence to escape from the vehicle)
- Excluded functions:* Functions for which the graphic symbol would not be used. (e.g. not to be used during normal service conditions.)



5 Stage 1: Generation of symbol variants



5.1 Objectives

The objectives of this stage are:

- to generate a wide variety of alternative graphical concepts for the given referent(s)
- to develop up to ten graphic symbol variants per referent for comprehensibility judgement testing

5.2 Creative workshop - preparation

In order to generate a wide selection of possible symbol variants, it is recommended that a creative workshop be organised.

5.2.1 Gather stimulus material

A wide variety of related graphic imagery should be gathered together as stimulus material for the workshop. This should include the existing set of safety sign symbols, symbols from other industries, application areas and standards, and any other relevant pictograms, diagrams or illustrations.

5.2.2 Recruit workshop participants

An ideal size for the workshop is 5 to 7 persons. The group should possess the following:

- knowledge of the symbol development and testing process (as defined in this document);
- knowledge of the symbol graphic guidelines (as defined in Appendix 1 of this document);
- knowledge of the defined referent(s), the operational context of use, and the functionality of any associated train equipment or devices;
- knowledge of human factors relevant to passenger behaviour in rail vehicles.

5 Stage 1 - Generation of symbol variants (cont)

5.2.3 Prepare referent description cards

For each referent, a description card shall be produced containing the information described in Section 4.2:

- Referent name;
- Field of application (including a photograph of the device or context of use);
- Referent function;
- Excluded functions.

5.3 Creative workshop - execution

Participants should be briefed on the process, including the following rules of conduct:

- generate as many ideas as possible;
- build upon the ideas of others;
- defer judgement until afterwards

Working through one referent at a time,

- Make all attendees aware of the referents context of use by describing the information contained on the 'referent card'.
- Display the 'referent card' together with any existing graphic symbol variants for each referent.
- As a group or as individuals, generate as many different concepts for each referent as possible, and display them adjacent to the 'referent information card' and copies of existing graphic symbol variants (if any).
- Use the sign catalogues to stimulate ideas if necessary.

5.4 Graphic development

All the concepts identified in the workshop shall be developed in strict accordance with the symbol graphics guidelines presented in Appendix 1.

The graphics guidelines have been derived from legibility research using luminous material in darkness, low-light and smoke-filled conditions. No compromises to the guidelines are permitted.

Graphics concepts shall be rejected if:

- they are too detailed to be constructed using the minimum line thickness;
- they are too complex to be represented with the minimum size of critical detail.

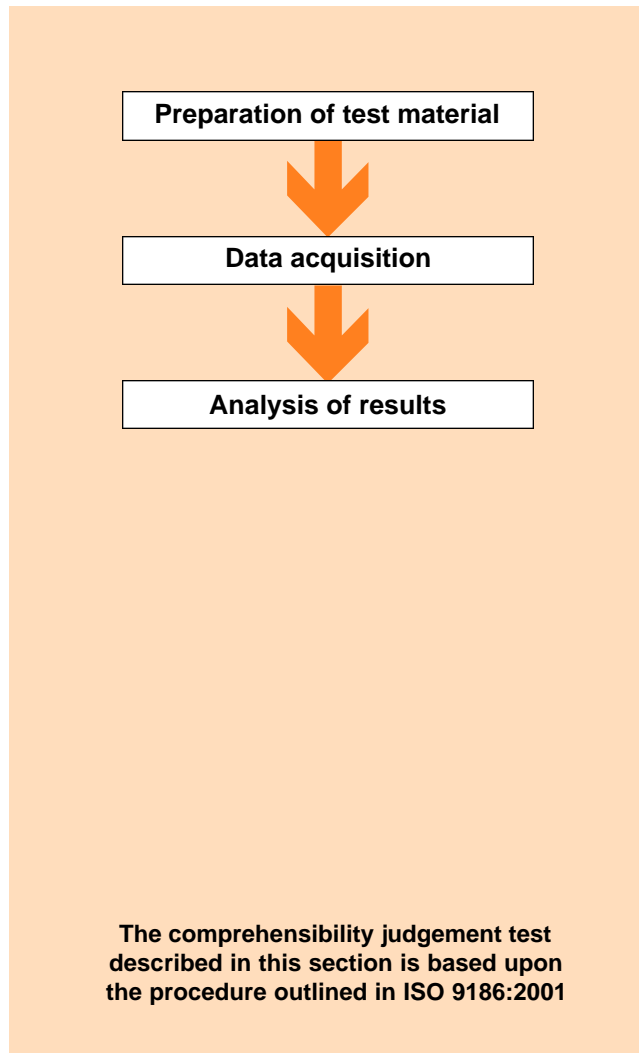
To aid the designer, it is recommended that the image of the symbol should be blurred within the drawing package being used. This can be used to identify opportunities to improve the graphical detail and achieve optimum legibility.

5.5 Variant selection

A maximum of 10 symbol variants may be taken forward to comprehensibility judgement testing. If a greater number of variants have been generated, the following selection criteria shall be used:

- 1 Include as many symbols with different graphical elements as possible.
- 2 Where two or more graphical symbol variants are very similar in graphical content, select one example to take forward.
- 3 Include graphical symbols that are already in use in other industries for the particular referent.
- 4 Avoid variants which might be confused with similar looking existing symbols, representing other referents, already in use on board UK rail vehicles.

6 Stage 2: Comprehensibility judgement test



6.1 Objectives

The objectives of this stage are:

- to estimate the comprehensibility of many symbol variants, based on the opinions of UK rail passengers.
- to enable the shortlisting of the strongest variants for the more rigorous comprehension test stage.

6.2 Preparation of test material

6.2.1 Symbol variants

- There shall be a maximum of ten variants per symbol.
- All symbol variants shall be designed to a consistent level of quality by complying with the graphic guidelines presented in Appendix 1.
- Symbols shall be presented in the appropriate colour: Green (Pantone 3405c) or Red (Pantone 185c). If the symbol can be used in either colour, the most commonly occurring version shall be used for testing.
- Symbol size shall be 30mm x 30mm.

6 Stage 2: Comprehensibility judgement test (cont.)

6.2.2 Test sheet

An A4-size test sheet shall be produced for each set of (up to ten) symbol variants.

The following written information shall be added:


- the referent name;
- the referent function;
- its field of application;
- excluded functions (if any).


Wherever possible, a photograph shall be added to the top right corner of the sheet to show the context of use or the specific device.

- for a device label (e.g. “Fire extinguisher”), the photograph shall show the general area where the symbol might be found.
- for an instruction referent (e.g. “Strike panel”), an image of the associated device shall be used.


The symbol variants shall be positioned equally-spaced around the circumference of a circle with a diameter of 100 mm, which has its centre at the centre of the sheet. A line for the participant’s response shall be drawn below each variant with the “%” sign added.

Strike panel


<p>Referent name Strike panel</p> <p>Referent function To instruct you to strike a panel to access a device or item of equipment below</p> <p>Field of application On board a train as part of a safety sign</p> <p>Excluded functions (if any) Not for non-emergency use.</p>	<p style="text-align: center;">Context of use</p> 
--	--




_____ %




_____ %




_____ %




_____ %



_____ %



_____ %



_____ %

Ref 3

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6 Stage 2: Comprehensibility judgement test (cont.)

6.2.4 Presentation order

The test sheets shall be compiled into 50 booklets with a maximum of 20 sheets in each. If more than 20 new referents are being developed, an additional set of 50 booklets shall be prepared to be seen by a different set of participants.

For every 50 booklets, there shall be at least 10 different random orders of test sheets (i.e. no more than 5 booklets in 50 shall have the same order of presentation).

6.2.5 Example sheet

An example test sheet shall be produced to the same specification as the other test sheets. It shall feature a referent which is not being tested and which is dissimilar to those being tested. Fictitious percentage scores shall be written-in under each variant on the example sheet to demonstrate that any percentage score between 0% and 100% is valid, and that the total of all the scores need not add-up to 100% (which is a common misconception).

6.2.6 Respondent data sheet

The front page of the booklet shall include space for the participant to record the following details about themselves:

- Frequency of rail travel
- Age
- Occupation
- Place of residence



6 Stage 2: Comprehensibility judgement test (cont.)

6.3 Data acquisition

6.3.1 Respondents

At least 50 members of the UK rail-travelling public shall participate. (N.B. ISO accreditation for the symbols would require testing in two additional countries (see ISO 9186)). The sample of respondents shall be representative as possible of the general population in terms of their:

- age
- gender
- educational level
- occupation
- cultural background

Respondents shall not be working within the railway industry and have no more than general knowledge about railway vehicles or safety devices. Respondents who have taken part in any previous tests of this type shall not take part again.

Each respondent shall respond to a maximum of 20 referents. If more than 20 referents are to be tested, a second set of different respondents is required.

6.3.2 Location for data capture

Conducting the data capture on-board a train is the recommended approach. Journeys shall cover a wide geographical area within the UK. However, if only a small number of referents are being tested, data acquisition at a number of major stations can be considered. Formal approvals must be sought from the relevant companies in advance.

6.3.3 Procedure

Approach the respondent and politely explain about the study. If they agree to take part, show the respondent the example test sheet and instruct them to:

- 1 Complete the personal details sheet.
- 2 Carefully read the information, provided in the top left corner of each test sheet.
- 3 Examine all the variants shown on the sheet.
- 4 Write down what percentage of the general population they think would correctly understand each of the symbols on the sheet.
- 5 Write their response (as a percentage) on the line directly below each variant.
- 6 Work through the whole booklet page by page.
- 7 Add any additional comments regarding the graphical design of the symbols.

The booklet can be left with the participant whilst other participants are approached. The test facilitator shall remain in the same carriage in case assistance is required, and to collect the completed booklets. A quick check should be made of each booklet to ensure that responses have been provided to all variants on all test sheets.

6 Stage 2: Comprehensibility judgement test (cont.)

6.4 Analysis of results

6.4.1 Tabulation

The results for each referent shall be tabulated, with one column for each variant and one row for each respondent. The median value of participant responses for each variant shall be calculated.

6.4.2 Pass-marks

As shown in the flowchart below, the pass-score shall be 66% and any variants achieving below that level shall be rejected.

6.4.3 Selection criteria

If more than three variants for any particular referent achieve the pass-mark, the best three shall be selected to go forward to Stage 3, using the following criteria.

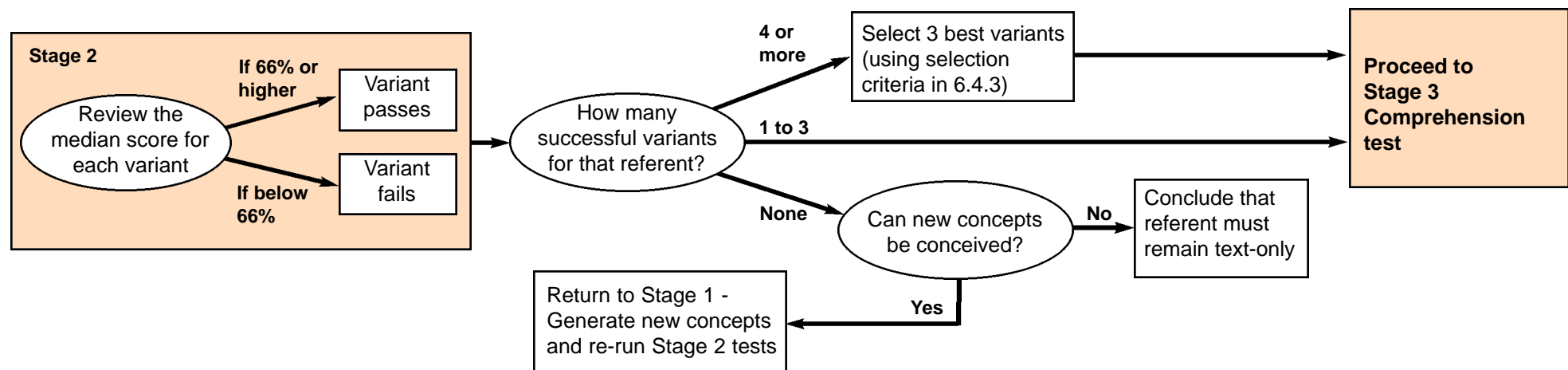
- The highest judgement scores.
- The variant with the simplest and boldest graphic design (for optimum legibility).
- The variant which has a graphic design least likely to be confused with other symbols.
- Variants which are in use in other industries for the same referent.

6.4.4 Design refinement

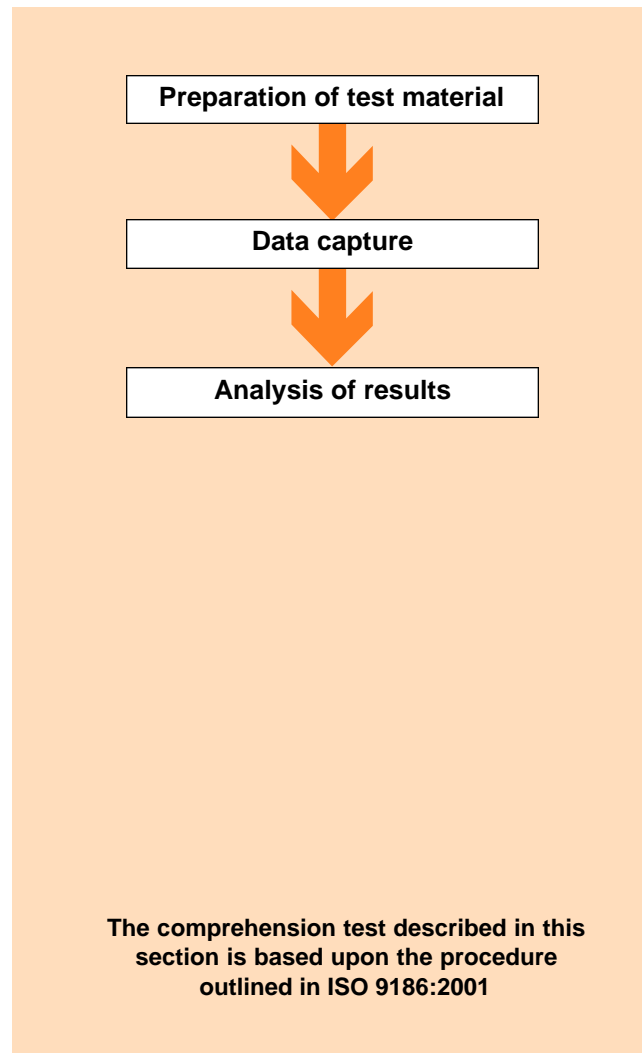
Minor refinement to symbol artwork is acceptable before proceeding to Stage 3 if there is evidence from the data to indicate probable benefits. No graphical elements shall be added or removed.

6.4.5 If no variants achieve the pass-mark

If, for a particular referent, no variants achieve the pass-mark, then new concepts must be generated and the Stage 2 testing process must be re-run. If no new concepts can be conceived, it shall be concluded that the particular referent must remain as text-only.



7 Stage 3: Comprehension test



7.1 Objectives

The objective of this stage is:

- to evaluate how well the shortlisted graphics symbols are comprehended by a representative sample of rail passengers.

7.2 Preparation of test material

7.2.1 Symbol variants

Symbol variants shall be classified into these two categories for the purposes of comprehension testing.

- 1 Referents referring to devices, equipment or abstract concepts.
- 2 Referents which instruct the passenger to perform an action.

The following common rules apply:

- A maximum of three symbol variants per referent is recommended for this stage. More can be tested, but additional participants would be required.
- Each symbol variant shall be graphically refined to be fully in line with the graphics guidelines presented in Appendix 1.
- Symbols shall be presented in the appropriate colour: Green (Pantone 3405c) or Red (Pantone 185c). If the symbol can be used in either colour, the most commonly occurring version shall be used for testing.
- Symbols shall be presented at 30mm x 30mm.



7 Stage 3: Comprehension test (cont.)

7.2.2 Test sheet for symbols denoting objects or devices (i.e. not instructions)

An A5-size test sheet shall be produced for each individual graphic symbol variant, containing:

- The individual symbol - located centrally as shown in the example on the right.
- An image showing the context of use (in this case its location in a doorway).
- Some words to describe the context of use - added above the image.
- The test question shall be: "What do you think this symbol means?"
- Space at the bottom for the participant's response.
- Reference code

**You may find this symbol on board a train
(see picture), as part of a safety sign.**



What do you think this symbol means?

(CAPITAL LETTERS PLEASE)

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7 Stage 3: Comprehension test (cont.)

7.2.3 Test sheet for instruction symbols

An A4-size test sheet shall be produced for each individual graphic symbol variant, containing:

- The symbol incorporated into an example instruction sign. All other symbols in the sign shall have been previously tested and approved, and the sign shall conform to the graphic guidelines contained in ITL/GN0001.
- The space where the associated symbol text would normally appear shall be left blank.
- An image showing the context of use (in this case a door).
- Some words to describe the context of use shall be added above the image.
- The test question shall be: "What action would you take in response to this symbol?"
- Reference code.


REF 17A (E)





The sign below shows a number of steps that you must complete to open a door in an emergency. You may find it in the location opposite (see photograph).


The text for the third instruction is missing.

What action would you take in response to this symbol?


Emergency door release

1

Break cover

2

Pull lever

3


Penalty for improper use

WRITE YOUR RESPONSE HERE IN CAPITAL LETTERS PLEASE

7 Stage 3: Comprehension test (cont.)

7.2.4 Test booklets

The test sheets shall be compiled into booklets.

- No booklet shall contain more than one variant for any referent (i.e. if there are three variants, they must be contained in three separate booklets and each tested on a different set of 50 people, see Section 7.3.1).
- Each booklet shall be tested on a set of 50 people, so 50 copies of each booklet will be required.
- There shall be no more than 20 sheets in each booklet. (If more than 20 referents are to be tested, a second set of booklets shall be produced.)
- The presentation order of the sheets shall be randomised.

7.2.5 Example sheet

An example test sheet shall be produced to the same specification as the other sheets to aid the briefing of the participant. It shall feature a symbol for a referent that is not being tested and is dissimilar to those being tested. If both types of test sheets are being used (as shown in Sections 7.2.2 and 7.2.3), then an example sheet for each type will be required.

7.2.6 Participant data sheet

The front page of the booklet shall include space for the participant to record the personal details shown in Section 6.2.6.

7 Stage 3: Comprehension test (cont.)

7.3 Data acquisition

7.3.1 Participants

At least 50 responses are required for each test booklet. No participant shall be asked to respond to more than one variant for any referent. So if there are three variants for any one symbol, then 150 (3 x 50) respondents shall be used.

The sample of respondents shall be representative of the eventual user population in terms of their:

- age;
- gender;
- educational level;
- occupation;
- cultural background.

Respondents who have taken part in any previous tests cannot take part again.

Each respondent shall each see a maximum of 20 referents. If more than 20 referents are to be tested, a second set of participants shall be used required.

7.3.2 Location for data capture

Conducting the data capture on-board a train is the recommended approach. Journeys shall cover a wide geographical area within the UK. However, if only a small number of referents are being tested, data acquisition at a number of major stations can be considered. Formal approvals must be sought from the relevant companies in advance.

7.3.3 Procedure

Approach the respondent and politely explain about the study. If they agree to take part, show the example test sheet and instruct them to:

- 1 Complete the personal details sheet.
- 2 Carefully read the information, provided in the top of each test sheet and examine the photograph.
- 3 Enter their response to the test question in the space provided. If the meaning is not known they should write "Don't know".
- 4 Work through the whole booklet page by page.
- 5 Add any additional comments regarding the graphical design of the symbols.

The booklet can be left with the participant while other participants approached. The test facilitator shall remain in the same carriage in case assistance is required, and to collect the completed booklets.

A quick check should be made of each booklet to ensure that responses have been provided to all variants on all test sheets.

7 Stage 3: Comprehension test (cont.)

7.4 Analysis of results

The analysis of the results for this stage is more complex than for Stage 2. The written responses must be judged by a panel of three independent judges before final comprehension scores can be compiled.

7.4.1 Tabulation

For each test sheet, the written answers from all 50 respondents shall be entered into a spreadsheet ready for scoring.

7.4.2 Independent judges

Three judges shall be recruited to review the responses in the spreadsheet. The judges shall:

- be from a company other than those involved in developing and testing the symbols, and not from the relevant train operating company or vehicle leasing company;
- have an awareness of human factors in relation to emergency situations, preferably with relevant human factors qualifications, but not necessarily working within the railway industry.

7.4.3 Information for the judges

A booklet shall be compiled containing the tables of responses together with an unmarked copy of the relevant test sheet. A copy of the booklet shall be sent to each judge in advance of a judges meeting.

The booklet shall include information and instructions for the judges as follows:

- background information about the project being conducted;
- a brief introduction to the comprehension testing process;
- list of judging categories (see right);
- instructions to the judges to aid categorisation of responses including examples;
- if a respondent has made no response at all for a variant, the correct categorisation is "No response given";
- if a respondent has recorded a question mark, a dash, a cross or any other sign on the page indicating that he/she does not know the meaning of the graphical symbol, the correct categorisation is "Don't know".

Judging categories for comprehension test responses

(as defined in ISO 9186)

- 1) Correct understanding of the symbol is certain (estimated probability of correct understanding **over 80%**)
- 2) Correct understanding of the symbol is very probable (estimated probability of correct understanding between **66% and 80%**)
- 3) Correct understanding of the symbol is probable (estimated probability of correct understanding between **50% and 65%**)
- 4) The meaning which is understood is opposite to that which is intended.
- 5) Any other response
- 6) The response given is "Don't know"
- 7) No response is given

7 Stage 3: Comprehension test (cont.)

7.4.4 Judges meeting

The objective of the judges meeting is to agree the appropriate category for each participant response for the symbols tested. The meeting shall be attended by the three judges and a non-voting chair-person. The chair-person shall have been involved with the symbol development process, and will be fully familiar with referents being developed and the operational and technical context of use.

The process shall be as follows:

- review the test sheets given to the participants;
- discuss each referent in turn before commencing judging process;
- discuss any operational issues or technical issues of associated equipment or devices to which the symbol may refer;
- agree the information / words / phrases which will affect to which category the response is assigned.
- work through each response and record the judges' consensus view of the appropriate category. If the judges cannot all agree, a majority decision may be accepted.

7.4.5 Weighted scoring system

The overall comprehension percentage score for each symbol variant shall be calculated using the following formula:

	(% of responses in category one)
PLUS	(% of responses in category two x 0.75)
PLUS	(% of responses in category three x 0.5)
MINUS	(% of responses in category four)
<hr style="border: none; border-top: 1px solid black;"/>	
=	Overall comprehension score (%)

7 Stage 3: Comprehension test (cont.)

7.4.6 Pass-marks

As can be seen in the flowchart below, any symbol which achieves an overall comprehension score of 66% or higher has passed the test and can go forward to Stage 4.

If the symbol represents an object or device (e.g. "Alarm" or "Emergency hammer"), it may be used without text when required. However, instructional symbols (e.g. "Pull handle" or "Slide door") shall always be used with text.

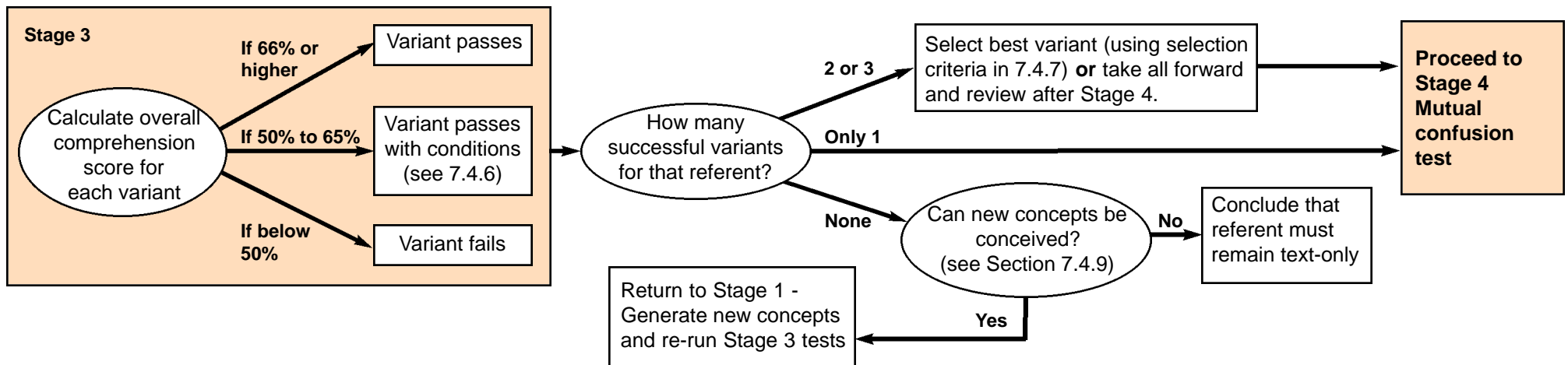
Any symbol achieving between 50% and 65% (inclusive) shall be subjected to a risk assessment based on the incorrect test responses, and with consideration of any potential hazards that those misinterpretations could introduce. If the risk assessment is satisfactory, the symbol can progress to Stage 4. When applied to a vehicle, the symbol shall always be used with text.

Any symbol which achieves an overall comprehension score of less than 50% has failed and shall not be taken forward to Stage 4.

7.4.7 Selection criteria

If more than one variant for any particular referent achieves the pass-mark, they can all be taken forward to Stage 4 if budget allows, or a selection can be made using the following criteria.

- The highest overall comprehension score.
- The variant with the simplest and boldest graphic design (for optimum legibility).
- The variant which has a graphic design least likely to be confused with other symbols.
- Variants which are in use in other industries for the same referent.



7 Stage 3: Comprehension test (cont.)

7.4.8 *Design refinement*

Minor refinement to symbol artwork is acceptable before proceeding to Stage 4 if there is evidence from the data to indicate probable benefits. No graphical elements shall be added or removed.

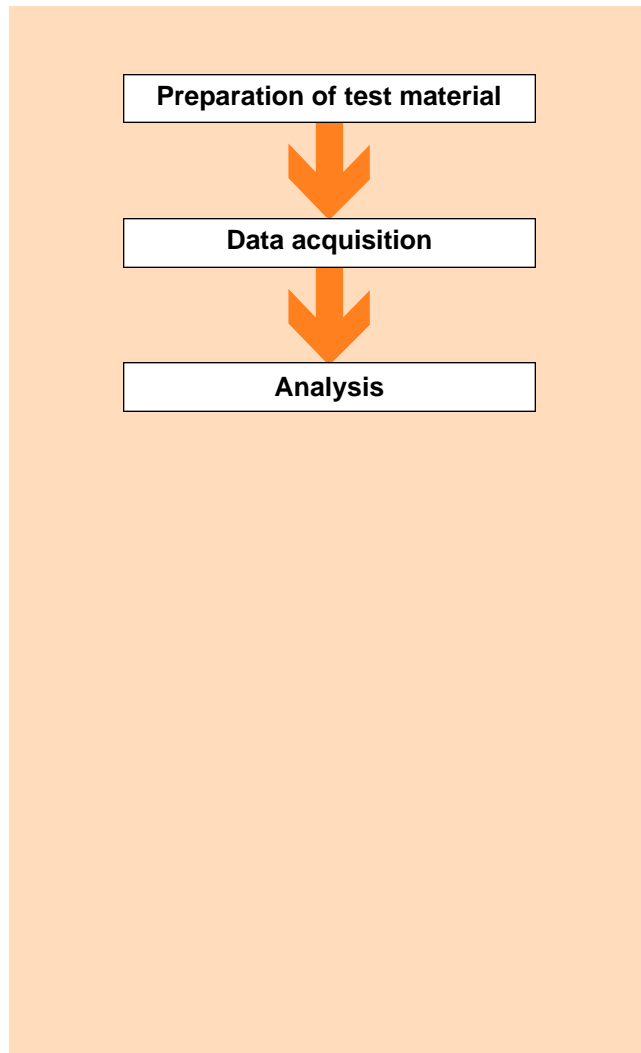
7.4.9 *If no variants achieve the pass-mark*

If, for a particular referent, no variants achieve the minimum comprehension pass-mark of 50%, then either:

- New graphic concepts must be conceived (i.e. return to Stage 1).
- Variants which passed Stage 2 testing but which were not taken forward to Stage 3, can be re-introduced and comprehension tested.
- Major revisions to the failed graphic symbols can be considered if the data indicates specific benefits might be achieved. Each will require further comprehension testing.

If no new concepts can be conceived, it shall be concluded that the particular referent must remain as text-only.

8 Stage 4: Mutual confusion test



8.1 Objectives

The objectives of this stage are:

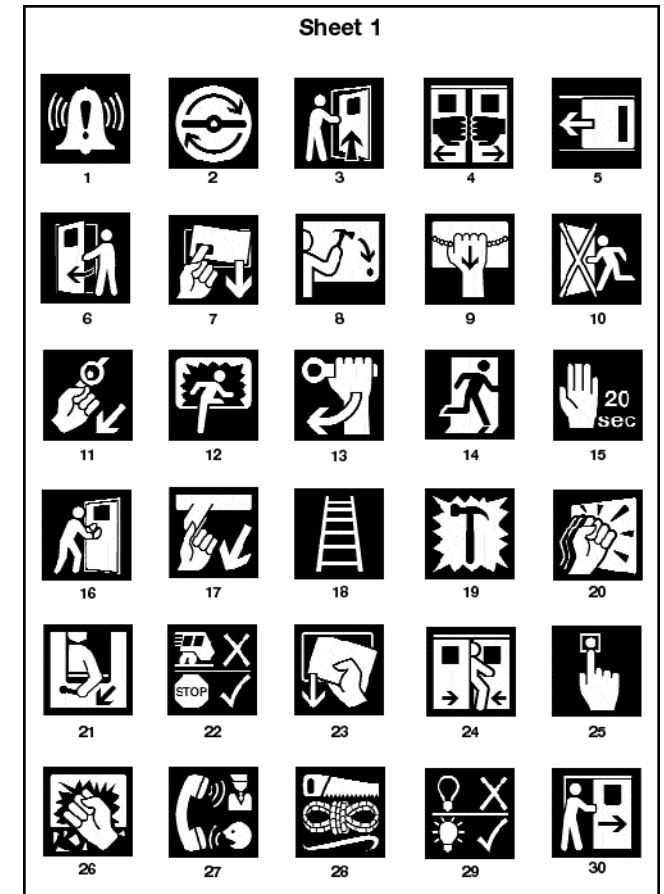
- to identify whether the new symbols are likely to be visually confused with any other symbols.
- to assess whether any confusions which do occur are likely to result in a safety hazard.

8.2 Preparation of test material

8.2.1 Test sheet

A test sheet shall be produced for each new symbol being tested. The sheets shall:

- be A4 in size and laminated for durability;
- contain a 5x6 matrix of symbols, each at 30mm x 30mm, and in black and white only;
- contain all the new symbol(s) for assessment - randomly located within the matrix;
- contain a randomly arranged selection from the existing set of approved symbols (including symbols which are graphically similar, and/or have meanings with which the new symbol must not be confused);
- include a sequential identification number under each symbol.



8 Stage 4: Mutual confusion test (cont.)

8.2.2 Data recording sheet

A simple sheet shall be prepared to record the respondents' personal details (as described in Section 6.2.6), and the symbol numbers given in response to the test question.

8.3 Data acquisition

8.3.1 Respondents

A minimum of 20 responses per symbol shall be obtained from a sample of the UK rail travelling public (as described in Section 7.3.1). Each respondent shall be asked about only one symbol (i.e. for 6 symbols, the number of respondents shall be 120 (6x20))

8.3.2 Location of data capture

Because the test is very quick, it is recommended that the data acquisition should take place on station concourses at a number of different locations around the UK. Formal approvals must be sought from the relevant companies in advance.

8.3.3 Procedure

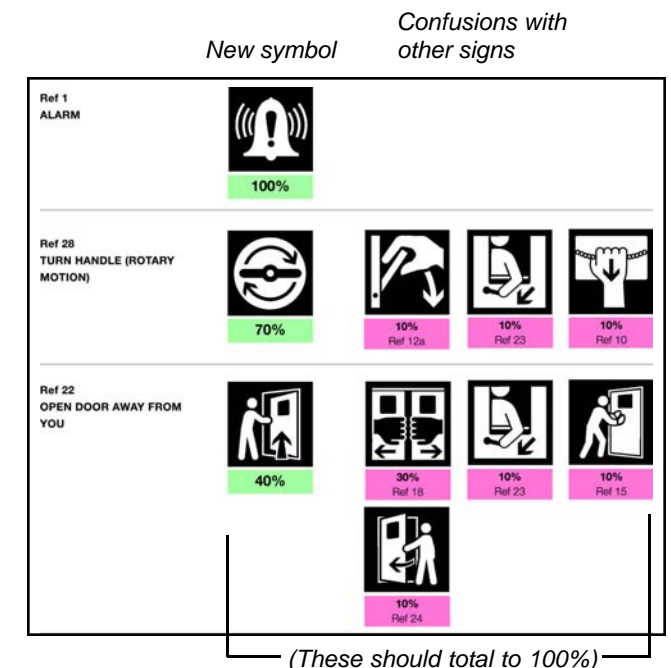
Approach the respondent and politely explain about the study. If they agree to take part:

- 1 Show the appropriate test sheet to the respondent;
- 2 Instruct the respondent to examine all the symbols on the sheet;
- 3 Ask the respondent to identify the symbol which they think means >insert referent name<;
- 4 Record the identification number of the selected symbol;
- 5 If the respondent selects the wrong symbol, it is vital to ask the respondent to describe what attributes of the symbol influenced their decision;
- 6 Add any additional comments regarding the graphical design of the symbols;
- 7 Ask for the respondent's personal details (as listed in Section 6.2.6).

8.4 Analysis of results

8.4.1 Tabulation

To aid the analysis, each new symbol shall be shown, together with those symbols which have been confused with the new referent. The percentage scores shall be added below each symbol.



8 Stage 4: Mutual confusion test (cont.)

8.4.2 Pass marks

If the new symbol has been correctly identified by 100% of the respondents, it has passed the test and can be submitted to ATOC for formal approval.

If confusions have occurred, there is no quantifiable pass mark. Instead a risk assessment is required (see Section 8.4.3), together with an analysis of the graphical elements which have caused the confusion (see Section 8.4.4).

8.4.3 Risk assessment

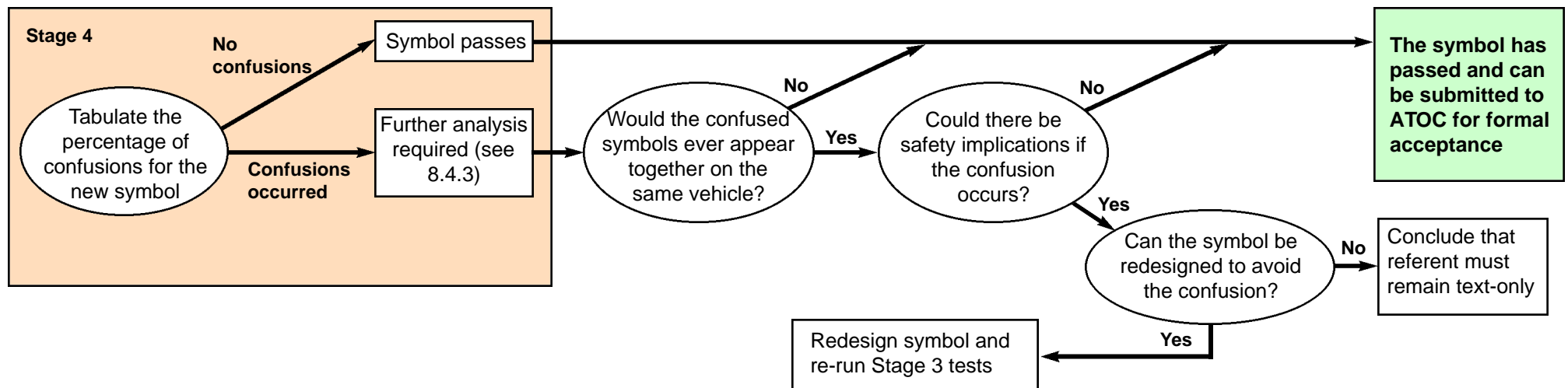
The risk assessment shall consider:

- 1 Whether the two confused symbols will ever appear near each other on the same vehicle.
- 2 The operational and safety consequences of the two symbols being confused under all conceivable operational scenarios.

If the symbol passes the risk assessment, it has completed the design and testing process and can be submitted to ATOC for formal acceptance.

8.4.4 Redesign

If the symbol fails the risk assessment, it must be redesigned to avoid the confusion. The redesigned symbol shall be tested for comprehension (i.e. return to Stage 3).



Appendices

The appendices provide the detailed procedures for each stage of the symbol development and testing process.

Appendix 1 Graphic guidelines for symbols

Appendix 2 Initial symbol set

Appendix 3 References

Appendix 1 Graphics guidelines for symbols

1.1 Introduction

This Appendix presents the graphics guidelines which shall be applied when designing new graphic symbols for use within safety signs. The guidelines are for use when a new referent has been defined and there is no suitable existing symbol.

The guidelines have been derived from industry best practice, relevant standards, and from the findings of specially commissioned research using luminous material in various lighting and smoke-filled viewing conditions. Any deviation from these guidelines could result in less than optimum symbol legibility.

The initial set of developed symbols is presented in Appendix 2. Guidelines for combining symbols with text and other sign elements are given in ITL/GN0001.

New symbols developed in line with these guidelines will normally be eligible for inclusion in the approved symbol set.

1.2 Prerequisites

It is necessary that:

- These guidelines are implemented by individuals with due competence in graphic design and an awareness of relevant human factors issues.
- The symbol artwork will be prepared using a suitable vector graphics drawing package such as Adobe Illustrator or Macromedia Freehand.

1.3 Consider the referent

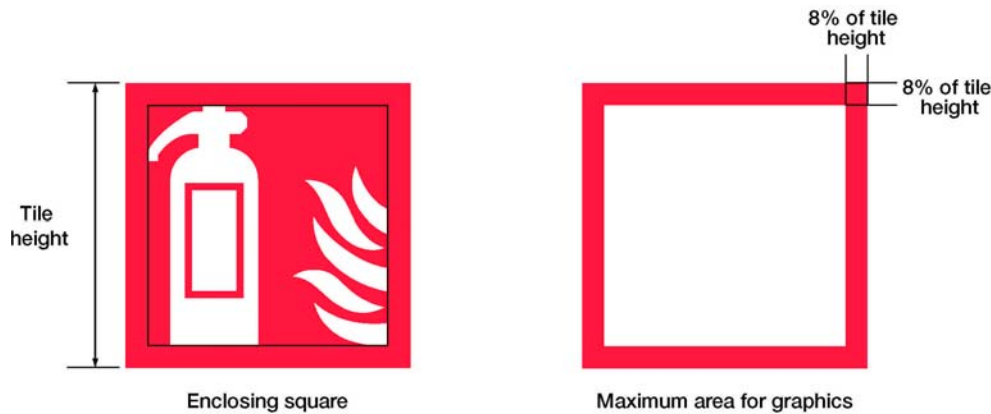
It is important to ensure that the referent is clearly defined from the outset. Symbols shall not be developed if the referent is ambiguous or the context of use is not known. The referent shall be revised if it is unclear or if it conveys two separate meanings or actions. For example, a referent which states: "Break cover and pull handle" shall be divided into two separate referents and represented by two separate symbols.



Appendix 1 Graphics guidelines for symbols (cont.)

1.4 The graphic symbol tile

All graphic symbols used in safety signs shall be designed with reference to an enclosing square, referred to as the graphic symbol tile, or simply the "tile". All graphic elements of a symbol shall be contained within a border equating to 8% of the tile height.



1.5 Tile size for construction purposes

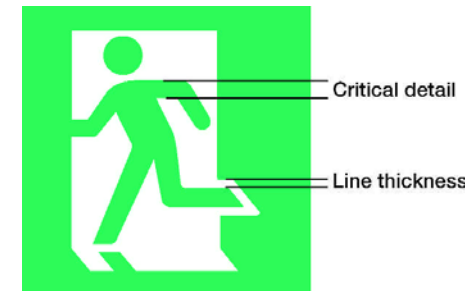
Symbols might have to be printed at sizes up to 100mm square. It is therefore important to use at least this size when constructing the artwork. When exporting from the vector graphics package, the minimum resolution shall be 300 dots per inch. For purposes of visualisation during construction, the relevant safety colours shall be represented by: Pantone 3405c (green) or Pantone 185c (red).

1.6 Critical detail

A critical detail of a graphic symbol is any visual element without which the meaning of the graphic symbol might not be comprehended. An example would be the arm of the "Running man" symbol. Minimum size is given below as a percentage of graphic tile size.

1.7 Line thickness

Any graphic line or clearance between critical details shall be no smaller than the proportions of graphic tile size given below.



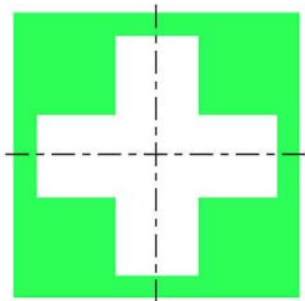
	Recommended minimum	Absolute minimum
Critical detail	8%	6%
Line thickness	2.4%	1.8%

(Percentages of graphic symbol tile size)

Appendix 1 Graphics guidelines for symbols (cont.)

1.8 Symmetry of design

Where possible, the symbol shall be symmetrical about the horizontal and / or vertical axes of the symbol tile.



Lines of symmetry

1.9 Alignment within the tile

Graphic symbols shall usually be centred within the tile. However this rule does not apply to arrows at 45° inclination.



Graphic symbol centred within white space area



45° arrows are not centred

1.10 Symbol orientation

Graphic symbols shall be orientated according to the direction of use. For example, the illustrations below show the same basic symbol indicating a clockwise or anti-clockwise handle rotation.



Example of symbol direction

Appendix 1 Graphics guidelines for symbols (cont.)

1.11 Graphical style

1.11.1 Harmony with existing symbols

The graphical style of any new symbols shall be in harmony with the initial set of approved symbols (see Appendix 2). Where possible, the artwork of an existing symbol shall be used as the starting point for a new symbol.

1.11.2 Simplicity

The graphical elements of the symbol shall be simple and bold, with good use of contrast, and with the avoidance of all non-essential detail.

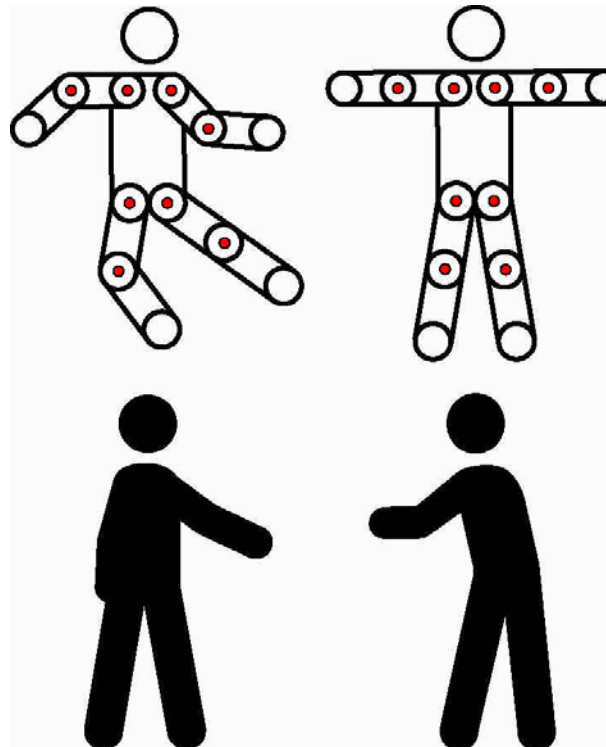
1.11.2 Hands

When depicting hands, the graphical style and level of minimum critical detail shall be as similar as possible to the examples in the initial symbol set (see examples below).



1.11.2 Human figures

When depicting the human form, the style of the figures shown below shall be used wherever possible.



1.11.3 Elements tapering to points

Graphic elements which taper towards a point shall be trimmed so that the point width is never less than the minimum line thickness (as in the example below).

1.11.4 Depth perception

Elements of a symbol can be made to stand-out from other elements by the use of thicker outlines (such as around the hand in the example below).



Appendix 1 Graphics guidelines for symbols (cont.)

11.12 Avoidance of text or numerals

Words, letters and numbers shall not be used within symbols used in safety signs.

Note: The "Pull" symbol (SYM-G017-GRN / RED) is intended for direct application to a device handle, and not for use within a sign.

11.13 Depict the user

Symbols requiring an action by the user (for example "Pull handle" or "Slide doors apart") shall, wherever possible, show a person (or part of a person) operating the device.

11.14 Depicting motion

Symbols depicting movement shall show an arrow pointing in the direction of motion. Two-dimensional arrows are most legible, but perspective arrows are required for some symbols. Where a rotational movement is required, a curved arrow shall be used which is concentric with the centre of rotation of the device.



11.15 Depicting device operation

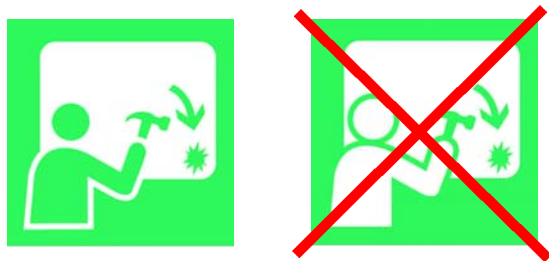
Where devices are to be operated, panels removed or doors opened, the symbols should ideally show the action in progress. For example, a hand on a vertical handle is less effective than the same hand with the handle slightly deployed. However, legibility rules shall not be compromised to achieve this.



Appendix 1 Graphics guidelines for symbols (cont.)

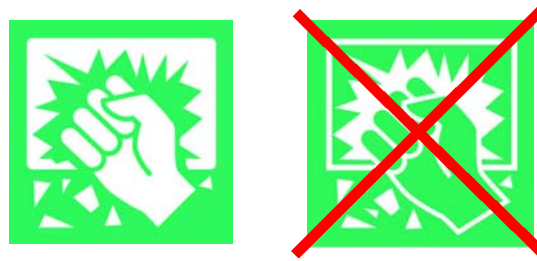
11.16 Make use of contrast

Graphical elements which contrast with the background are far more legible than if depicted by an outline alone.



11.17 Logical use of light and dark

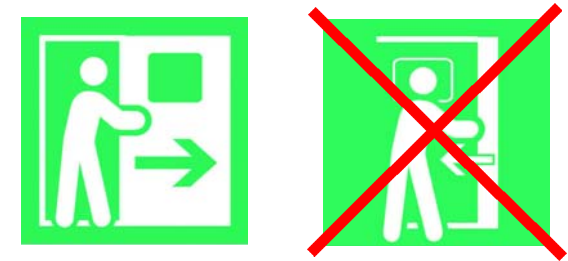
The darker safety colour (whether green or red) and the lighter contrast colour shall be used logically where possible. For example, holes in things should be darker.



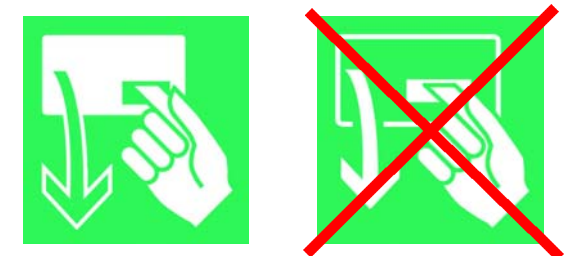
11.18 Highlighting the key features

The key feature of the referent should be highlighted in the lighter contrast whenever possible.

For "Slide door", the door should be the lighter contrast colour.



For "Remove panel", the panel should be lighter contrast colour.



Appendix 2 - Initial symbol set

Presented in this Appendix is the initial set of symbols that have been developed using the symbol design and testing procedure.

Artwork

The symbol artwork is available for download from the ATOC website for authorised users. This Appendix is for reference only. **Symbols must not be reproduced from this Appendix.**

Symbol groups

- Set A Arrows
- Set B Objects and equipment
- Set C Covers and panels
- Set D Doors
- Set E Emergency exits and windows
- Set F Miscellaneous
- Set G Graphics to be applied to devices
- Set H Handles and devices

Associated wording

- The recommended wording is shown next to each symbol in **bold**.
- Additional notes and examples of alternative wording are shown in (brackets).
- Where no words are shown in bold, the symbol is used to supplement text-only referents, or is not used with text (e.g. arrows).

Appendix 2 - Initial symbol set (cont.)

Set A - Arrows

Escape route direction arrows are derived from the BS symbol. BS 5499-1 specifies that these symbols shall always be used with text (usually either "Exit" or "Emergency exit")

Escape route direction (progress to the right)



SYM-A001-GRN

Escape route direction (progress to the left)



SYM-A002-GRN

Escape route direction (progress straight forward, forward through here, or forward and up)



SYM-A003-GRN

Escape route direction (progress down)



SYM-A004-GRN

Escape route direction (progress up to the right, or forward and across to the right)



SYM-A005-GRN

Escape route direction (progress up to the left, or forward and across to the left)



SYM-A006-GRN

Escape route direction (progress down to the right)



SYM-A007-GRN

Escape route direction (progress down to the left)



SYM-A008-GRN

Appendix 2 - Initial symbol set (cont.)

Set A - Arrows (cont)

These arrows indicate directions toward objects and equipment - but not escape routes.

General direction
arrow (right)



SYM-A009-GRN



SYM-A009-RED

General direction
arrow (left)



SYM-A010-GRN



SYM-A010-RED

General direction
arrow (up)



SYM-A011-GRN



SYM-A011-RED

General direction
arrow (down)



SYM-A012-GRN



SYM-A012-RED

General direction
arrow (up to the
right)



SYM-A013-GRN



SYM-A013-RED

General direction
arrow (up to the
left)



SYM-A014-GRN



SYM-A014-RED

General direction
arrow (down to the
right)



SYM-A015-GRN



SYM-A015-RED

General direction
arrow (down to the
left)



SYM-A016-GRN



SYM-A016-RED

Appendix 2 - Initial symbol set (cont.)

Set B - Objects and equipment

These symbols can be used without text if necessary.

First aid box
 (Derived from BS symbol)



SYM-B001-GRN

Emergency ladder
 (Derived from BS symbol)



SYMB002GRN

Emergency equipment
 (generic symbol for any combination of equipment)



SYM-B003-GRN

Emergency hammer
 (for breaking window glass)



SYM-B004-GRN

Fire extinguisher
 (Derived from BS symbol)



SYM-B005-RED

Alarm
 (or passenger communication device)



SYM-B006-RED

Green dot (for indicating corners of windows) (to be used with SYM-E008-GRN)



SYM-B007-GRN

Appendix 2 - Initial symbol set (cont.)

Set C - Covers and panel

These symbols shall always be used with text.

Break cover
(or panel)



SYM-C001-GRN



SYM-C001-RED

Strike cover
(or panel)



SYM-C002-GRN



SYM-C002-RED

Remove cover
(or panel)



SYM-C003-GRN



SYM-C003-RED

Remove cover
(or panel) (insert
finger in slot)



SYM-C004-GRN



SYM-C004-RED

Remove cover
(or panel) (pull tab)



SYM-C005-GRN



SYM-C005-RED

Remove cover
(or panel) (ring pull)



SYM-C006-GRN



SYM-C006-RED

Slide cover
(or panel) (to left)



SYM-C007-GRN



SYM-C007-RED

Slide cover
(or panel) (to right)



SYM-C008-GRN



SYM-C008-RED

Appendix 2 - Initial symbol set (cont.)

Set D - Doors

These symbols shall always be used with text.

Open door towards you
(hinge to left)



SYM-D001-GRN

Open door towards you
(hinge to right)



SYM-D002-GRN

Open door away from you
(hinge on right)



SYM-D003-GRN

Open door away from you
(hinge on left)



SYM-D004-GRN

Slide door open
(to right)



SYM-D005-GRN

Slide door open
(to left)



SYM-D006-GRN

Open door using outside handle
(handle to user's right)



SYM-D007-GRN

Open door using outside handle
(handle to user's left)



SYM-D008-GRN

Pull doors apart



SYM-D009-GRN

Push door(s)
(plug door)
(normally used with
and preceding
symbols D009,
D005, D006)



SYM-D010-GRN

Appendix 2 - Initial symbol set (cont.)

Set E - Emergency exits and windows

These symbols shall always be used with text.

Escape route
 (to right) (Derived
 from BS symbol)



SYM-E001-GRN

Escape route
 (to left) (Derived
 from BS symbol)



SYM-E002-GRN

**Emergency
 window**
 (or Emergency exit)
 (to right)



SYM-E003-GRN

**Emergency
 window**
 (or Emergency exit)
 (to left)



SYM-E004-GRN

**No emergency
 exit**



SYM-E005-GRN

**Escape through
 window**



SYM-E006-GRN

**Strike window in
 corner**
 (using hammer)



SYM-E007-GRN

**Strike window in
 corner**
 (on green dot)
 (using hammer)
 (to be used with
 SYM-B007-GRN)



SYM-E008-GRN

Set F - Miscellaneous

These symbols shall always be used with text.

Speak with crew
 (speak with driver)
 (or other nominated
 staff member)



SYM-F001-RED

Wait
 (Text shall add
 clarification - see
 Appendix 2)



SYM-F002-GRN



SYM-F002-RED

Lock override
 (Used only on
 doors that are:
 • normally staff-only
 but form an
 escape route;
 • normal
 thoroughfares but
 locked-out-of-
 service)



SYM-F003-GRN

Appendix 2 - Initial symbol set (cont.)

Set G - Graphics to be applied to devices

These graphics are for application to devices to indicate the appropriate direction of operation. They are not intended for application as graphic symbol tiles within signs.

Curved direction arrow (0°-180° clockwise)



SYM-G001-GRN



SYM-G001-RED

Curved direction arrow (90°-270° clockwise)



SYM-G002-GRN



SYM-G002-RED

Curved direction arrow (180°-0° clockwise)



SYM-G003-GRN



SYM-G003-RED

Curved direction arrow (270°-90° clockwise)



SYM-G004-GRN



SYM-G004-RED

Curved direction arrow (0°-180° anti-clockwise)



SYM-G005-GRN



SYM-G005-RED

Curved direction arrow (270°-90° anti-clockwise)



SYM-G006-GRN



SYM-G006-RED

Curved direction arrow (180°-0° anti-clockwise)



SYM-G007-GRN



SYM-G007-RED

Curved direction arrow (90°-270° anti-clockwise)



SYM-G008-GRN



SYM-G008-RED

Curved direction arrow (0°-90° clockwise)



SYM-G009-GRN



SYM-G009-RED

Curved direction arrow (90°-180° clockwise)



SYM-G010-GRN



SYM-G010-RED

Curved direction arrow (180°-270° clockwise)



SYM-G011-GRN



SYM-G011-RED

Curved direction arrow (270°-0° clockwise)



SYM-G012-GRN



SYM-G012-RED

Appendix 2 - Symbols and referents

Set G - Graphics to be applied to devices (cont.)

These graphics are for application to devices to indicate the appropriate direction of operation. They are not intended for application as graphic symbol tiles within signs.

Curved direction arrow (0°-270° anti-clockwise)



SYM-G013-GRN



SYM-G013-RED

Pull here
(to be applied directly to appropriate handles)



SYM-G017-GRN



SYM-G017-RED

Curved direction arrow (270°-180° anti-clockwise)



SYM-G014-GRN



SYM-G014-RED

Curved direction arrow (180°-90° anti-clockwise)



SYM-G015-GRN



SYM-G015-RED

Curved direction arrow (90°-0° anti-clockwise)



SYM-G016-GRN



SYM-G016-RED

Appendix 2 - Initial symbol set (cont.)

Set H - Handles and devices

These symbols shall always be used with text.

Pull handle
(open solid flap /
hinged at bottom)



SYM-H001-GRN



SYM-H001-RED

Pull handle
(open solid flap
positioned in roof)



SYM-H002-GRN



SYM-H002-RED

Pull handle
(solid flap hinged at
left side)



SYM-H003-GRN



SYM-H003-RED

Pull handle
(solid flap hinged at
right side)



SYM-H004-GRN



SYM-H004-RED

Pull lever
(stick style)



SYM-H005-GRN



SYM-H005-RED

Turn handle
(or Pull down
handle)
(clockwise)



SYM-H006-GRN



SYM-H006-RED

Turn handle
(or Pull down
handle)
(anti-clockwise)



SYM-H007-GRN



SYM-H007-RED

Pull up handle
(or Turn handle)
(clockwise)



SYM-H008-GRN



SYM-H008-RED

Pull up handle
(or Turn handle)
(anti-clockwise)



SYM-H009-GRN



SYM-H009-RED

Pull up handle
(clockwise)



SYM-H010-GRN



SYM-H010-RED

Pull up handle
(anti-clockwise)



SYM-H011-GRN



SYM-H011-RED

Pull down handle
(or Turn handle)
(clockwise)



SYM-H012-GRN



SYM-H012-RED

Pull down handle
(or Turn handle)
(anti-clockwise)



SYM-H013-GRN



SYM-H013-RED

Push button
(Derived from BS
symbol)



SYM-H014-GRN



SYM-H014-RED

Appendix 2 - Initial symbol set (cont.)

Set H - Handles and devices (cont.)

These symbols shall always be used with text.

Turn handle
(clockwise - rotary style)



SYM-H015-GRN



SYM-H015-RED

Turn handle
(anti-clockwise - rotary style)



SYM-H016-GRN



SYM-H016-RED

Pull handle
("T" style)



SYM-H017-GRN



SYM-H017-RED

Pull chain



SYM-H018-RED

Appendix 3 References

ISO 9186 (2001)

Graphical symbols – test methods for judged
comprehensibility and for comprehension
International Organisation for Standardisation,
Geneva

BS 5378: 1980

Safety signs and colours
Part 2: Specification for colorimetric and photometric
properties of materials (Table 4. Colour references)
British Standards Institute

BS 5499: 2002

Safety signs, including fire safety signs
Part 1: Specification for geometric shapes, colours
and layouts
Part 4: Code of practice for escape route signing
Part 5: Signs with specific safety meanings
British Standards Institute

ITL/GN0001

Graphic guidelines for safety signs
Issue 1, April 2003

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