HSE
Health and Safety Executive

Colour vision examination

A guide for employers

1 This guidance provides general information on colour vision tests for managers and others who may need to use them. Employers may also wish to refer to Guidance Note MS7 *Colour vision examination: A guide for occupational health providers*,[1] which provides guidance for occupational health advisers on colour vision testing. A flow chart is included to help managers and occupational health advisers in designing appropriate strategies for identifying, classifying and grading colour vision deficiencies. If an employer has employees whose colour vision is important for safety critical purposes then colour vision testing is crucial in deciding on their fitness for work. However, in companies where colour vision needs are not associated with safety-critical systems but with product quality, colour vision testing is valuable to avoid costly errors.

INTRODUCTION

2 When considering safety, colour is used in a number of ways, eg identifying the most appropriate resistor (an electrical component) to use from the different bands of colour on the resistor, or cylinders and pipes which may have part of their bodies colour coded to indicate their content. Where safety depends entirely on the correct recognition of a colour code, for example in some electrical and electronic engineering work, and in some transport applications (eg train driver), normal colour vision will be required. There are some jobs though where safety considerations are minimal but quality control requires the correct identification of colours, eg in industries such as textiles, paper manufacture, dyes and paints.

3 A person with a colour vision defect perceives a wide range of different colours as being the same, which to a colour-normal person appear to be different. The colour confusions are variable and can be mild, moderate or severe. In some cases, individuals are not aware of their defective colour vision until errors are made. Inherited colour vision defects are found among 1 in 12 of the male population. This number is similar for those with acquired defects aged over 45, and rises to 1 in 4 in the over 75's.

4 A whole range of defects are found in practice. While some people confuse bright colours, others may only have problems with pale colours exacerbated if the level of illumination is low. Colour confusions can also occur when tasks involving small areas of colour are present, or where larger areas are viewed at a distance.

5 Colour vision defects can be inherited, or can be acquired at any time during life. Inherited colour vision defects are carried by mothers through to their sons. Inherited red-green colour defects are the most common form of colour deficiency, and minor or moderate problems are found in about 8% of the male population (1 in every 12 individuals) with blue-yellow defects being rarely inherited. Women are rarely affected (around 1 in 200 of the female population) since they carry the defect to their sons. Acquired colour vision defects may occur as the result of

general diseases such as long-standing diabetes, cardiovascular disturbances, multiple sclerosis, and liver diseases and are commonly found in almost all eye diseases, eg optic nerve disease, glaucoma, and cataracts. They may arise as a result of exposure to industrial chemicals (eg solvent exposure is thought to be associated with subtle colour vision deficits and HSE is currently reviewing the evidence for this) and as side effects of therapeutic drugs, eg anti-inflammatory agents to treat rheumatoid arthritis, the contraceptive pill and cardiac agents, or recreational drug abuse, eg tobacco or alcohol. Many acquired defects are of the blue-yellow variety although red and green perception is often involved.

6 The retina of the eye has two types of light-sensitive cells, named rods and cones. The cones are closely packed together in the fovea, which is located in the central part of the retina. The function of the cones is to perceive the surrounding environment as accurately as possible in conditions of good light. Cones function in our daylight vision and are responsible for colour discrimination. Rods function in conditions of low light and lie largely outside the fovea, increasing in numbers towards the outer parts of the retina, to allow night vision.

7 Individuals with normal colour vision have three types of functional cone cells which have maximum sensitivity in the red, green and blue parts of the spectrum. Inherited colour vision defects can occur when one of the three cone types is either faulty or absent (a major colour vision defect known as 'dichromatism') or when one of the cone types has a different spectral sensitivity compared with normal (a minor or moderate colour vision defect, known as 'anomalous trichromatism').

8 There are three classes of colour deficiency, red (protanopia), green (deutanopia) and blue (tritanopia). Red and green defects are known collectively as red-green colour deficiency and are the most common type of inherited colour deficiency. Tritan defects involve colour confusions between blue and yellow, violet and red, and blue and green. These are rare in inherited form in comparison with red and green defects but are common as an acquired form of colour vision defect. For more information on the mechanisms of colour vision perception and acquired defects see *Colour vision examination: A guide for occupational health providers* MS7.[1]

9 A colour vision deficiency is unlikely to constitute a disability for the purposes of the Disability Discrimination Act 2005 unless there is a total inability to distinguish colours, which occurs very rarely. Work tasks should ideally be designed to minimise the number of situations which depend on the accurate assessment of colour vision by the human eye. However, there may be a need to reassess regularly using colour vision testing to ensure that this is still true over a person's working life.

10 This document provides guidance for employers on colour vision testing. For full lists of careers, occupations and industrial activities which require normal colour vision see *Defective colour vision: Fundamentals, diagnosis and management.*[2]

COLOUR VISION ASSESSMENT

11 If colour vision assessment is required in order to evaluate the ability of an individual to perform one or more specific tasks, this is often carried out at the pre-employment stage. In addition, annual checks for possible acquired defects are desirable in certain work situations. Tests are used to ensure that the worker can perform all tasks efficiently and safely, and for those over 40 years of age. In production situations, good colour recognition can be essential, as although colour

matching is often undertaken by computer, the final assessment is often by visual inspection. For each individual task, employers must assess the importance of good colour recognition, while considering safety and efficiency issues such as error rates.

COLOUR CODING

12 Colour codes are important in the workplace as a means of establishing (by visual cues) specific information that a worker needs to perform a task either safely or more efficiently. There are two types of colour coding used regularly; these are connotative and denotative.

Connotative colour coding

13 In connotative coding, colour is the only means of information transfer and the code has to be identified correctly to ensure the safe operation of the activity. Connotative codes convey specific information such as rights of way in transport systems, eg railway signalling, or in the electrical industry, an indication of electrical wiring.

14 If good colour recognition is important because connotative colour coding is used, the employer should consider modifying the workplace/machine to use denotative colour coding.

Denotative colour coding

15 Denotative codes enhance information that is provided by other distinguishing features, such as position, sequence, shape or text. In this case, colour is said to be used redundantly. Road traffic signals, industrial gas cylinders and business files come into this category. Colour recognition improves long-distance information acquisition, reduces search time and improves performance in sorting tasks. Colour-deficient people may work more slowly than their colour-normal colleagues and may have to ask for assistance in some colour tasks, and they require higher illumination levels to work safely and accurately.

Application of colour coding to the workplace

16 If redesigning the workplace or machinery to eliminate connotative colour coding is not possible, or denotative colour coding is used but good colour recognition is still required, the employer is advised to prepare a medical schedule for colour vision testing that specifies the following:

- a list of the tasks in which good colour vision is important (considering efficiency and safety);
- identification of appropriate colour vision examination methods using appropriate lighting levels and types;
- a clear definition of the degree of deficiency that is acceptable (if any);
- the colour vision assessment will need to be carried out either by an occupational nurse or an optometrist, referred to in this document as examiners;
- the procedure for handling of borderline decisions, eg further testing by a person with specialist knowledge on colour vision and suitable equipment and experience;
- deciding if the defect is either acquired or inherited.

Colour vision testing policy

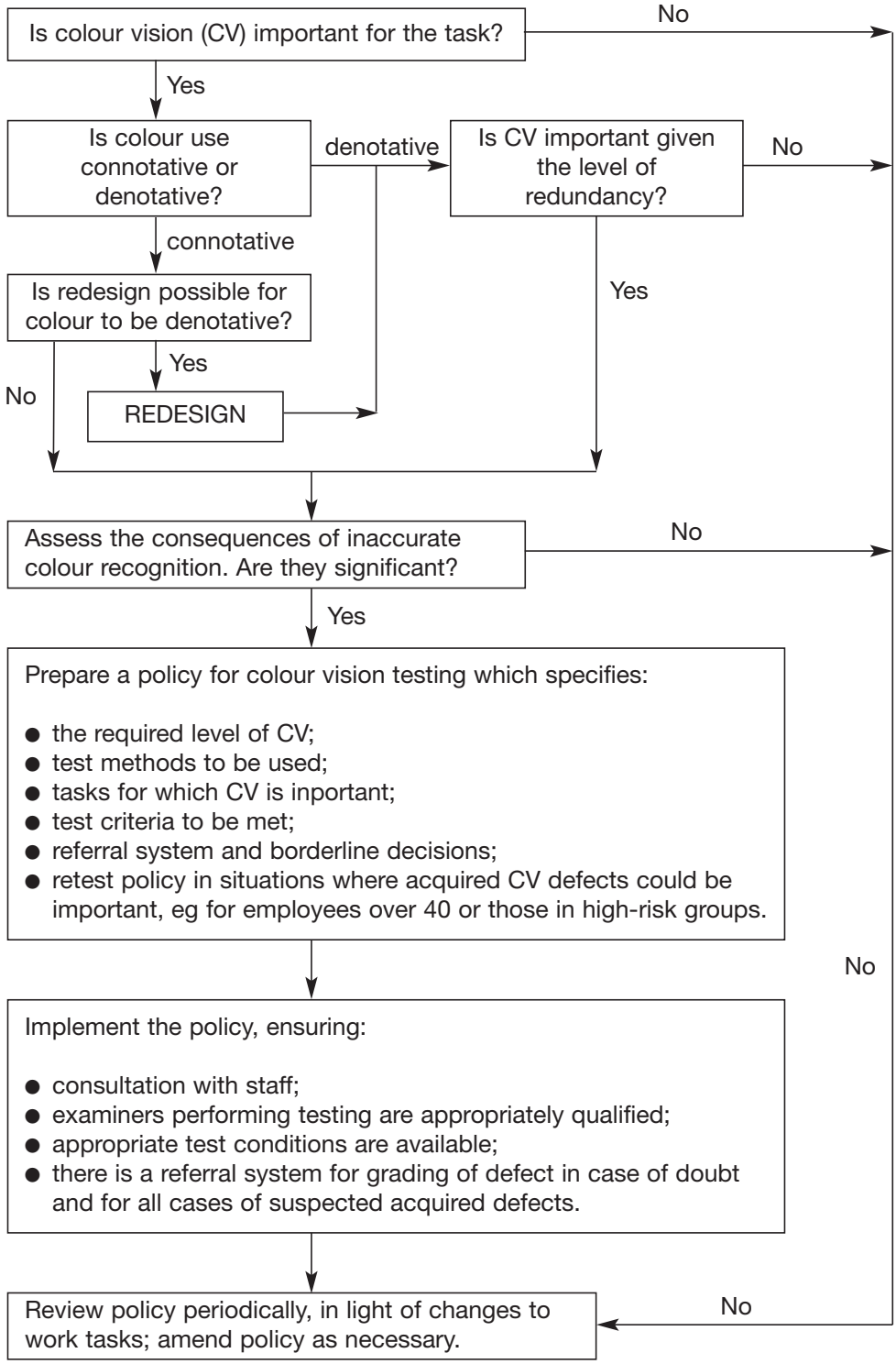
17 The policy for colour vision testing should be implemented throughout the company, ensuring that:

- all the staff have been consulted/notified, including their worker safety representatives;
- employers have clearly defined the level of colour vision considered acceptable for a given colour vision work task;
- the examiners have undergone comprehensive training in the techniques of administering colour vision testing;
- appropriate testing conditions are used (see *Test conditions*);
- procedures are in place for recording results, maintaining records and provision for the assessors to inform management of the results, ie pass, fail, degree of difficulty etc.

18 Finally, the policy should be reviewed periodically to take account of any changes to the work tasks, machinery and the working environment. The flow chart (Figure 1) will assist the reader in understanding the principles of colour vision testing procedures.

19 A procedure for testing individuals who are currently in employment should be distinct from that for pre-employment testing. The ability to discriminate between colours from acquired defects can change with age, general health, and eye disease and as a result of therapeutic medication taken. Therefore annual testing is advisable and should be discussed with managers and employees. Where safety-critical colour decisions are involved, workers should be tested annually.

Figure 1: Principles of colour vision testing



COLOUR VISION EXAMINATION

20 A variety of colour vision tests are available with different pass/fail criteria. Some only screen colour vision defects while others classify and grade them. There is no one recommended colour vision test and employers should, in consultation with an occupational health provider, make an assessment of what test methodology best suits their particular needs.

21 The classification (red, green or blue defect, inherited or acquired) and grading (mild, moderate or severe) of colour deficiency is important when deciding a policy. Employers should note that some but not all colour vision tests provide a means to classify and diagnose a colour vision defect. The colour vision tests described can provide a classification and severity rating but correct classification and grading takes time, experience, training, and when necessary, a confirmatory second colour vision test. A policy for colour vision testing should stipulate whether the subject is or is not suitable for employment, based on the pass/fail criterion of the colour vision test chosen. In borderline decisions, the examiner may wish to consider using some form of practical assessment based on a typical colour-related work activity that employee does.

22 Tests most likely to be encountered are the Ishihara plate test, City University test and the colour vision lantern test; these are the three main clinical methods used to achieve the above aims in occupational settings. 'Trade tests' are not standardised but may, in addition to a clinical test, prove helpful in some work situations (see MS7).[1] Lantern tests have a specific value in cases where the correct recognition of coloured lights is critical, eg maritime, aviation, road or rail transportation.

23 When administering an occupational colour vision test, the subject should wear their normal vision aids, test lighting conditions should be as specified for the test and the examiner should have normal colour vision (see MS7).[1] The choice of test should take into account the colour vision requirements for the tasks involved and use a suitable pass/fail criterion relevant to the job. The Ishihara plate test is a screening test only and gives an indication of red-green defects. Blue-yellow defects (usually acquired) cannot be detected by Ishihara plates. In some occupations where only screening of red-green colour vision is required, the Ishihara test might be adequate. On the other hand, for some occupations a mild/moderate colour vision deficiency is acceptable and in such cases the City University diagnostic test is an ideal choice, as it grades and types the severity of the defect. Normally other visual impairments will be present with an acquired defect (see MS7).[1] In these situations it is important that other medical specialists are consulted, as an underlying condition not related to colour vision may be the cause and that condition may require treatment.

24 Employers must decide whether a person with a slight defect is acceptable for the colour tasks they are required to perform and chose the test accordingly. Subjects who pass the City University test but fail the Ishihara plate test are likely to have practical difficulties with only the most demanding colour discrimination tasks in an occupational context, such as situations involving colour recognition of transport signals. In these cases lantern and trade tests can be used to determine suitability.

REFERENCES AND FURTHER READING

References

1 *Colour vision examination: A guide for occupational health providers* Medical Guidance Note MS7 (Third edition) HSE 2005 (available online at: www.hse.gov.uk/pubns/ms7.pdf)

2 Fletcher R and Voke J *Defective colour vision: Fundamentals, diagnosis and management* Institute of Physics 1985 ISBN 0 85 274395 5

Further reading

A practical guide: Employment adjustments for people with sight problems Employers Forum on Disability 2000

Cox R A *Fitness for work: The medical aspects* (Third Edition) Oxford University Press 2000 ISBN 0192630431

Successful health and safety management HSG65 (Second edition) HSE Books 1997 ISBN 0 7176 1276 7

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