Design Factors of Safety

Below are excerpts from the Machinery Directive 2006 where they define lifting accessories. The article also includes deign factors (co-efficiency) for these accessories.
Following this are further sections taken from the British Standards 7905 and 7906 (use of lifting equipment for performance) and from the LOLER AC0P (lifting of people).

- **British Standard 7905**: Unless equipment used for performer flying has been specifically designed for that purpose, the components (e.g. flying bar or shackle) shall be used at no more than 50% of the manufacturers stated SWL
- **British Standard 7906**: Flying cables and ropes should have a design factor of 10:1
- **LOLER (**ACoP): Equipment used for lifting people should be downrated by 50%

Also included are references from design factors for flying of performers from Canada in their publication “Performer Flying and Aerial Stunts” with design factors (MBS) of 10:1

Machinery Directive 2006
9.6.2006 EN Official Journal of the European Union L 157/24

This Directive applies to the following products:

(a) machinery;

(b) interchangeable equipment;

(c) safety components;

(d) lifting accessories;

(e) chains, ropes and webbing;

(f) removable mechanical transmission devices;

(g) partly completed machinery.

(d)‘lifting accessory’ means a component or equipment not attached to the lifting machinery, allowing the load to be held, which is placed between the machinery and the load or on the load itself, or which is intended to constitute an integral part of the load and which is independently placed on the market; slings and their components are also regarded as lifting accessories;

(e)‘chains, ropes and webbing’ means chains, ropes and webbing designed and constructed for lifting purposes as part of lifting machinery or lifting accessories;

4.1.1. Definitions

(a)'Lifting operation' means a movement of unit loads consisting of goods **and/or persons** necessitating, at a given moment, a change of level.

4.1.2.4. Pulleys, drums, wheels, ropes and chains

Pulleys, drums and wheels must have a diameter commensurate with the size of the ropes or chains with which they can be fitted.
Drums and wheels must be designed, constructed and installed in such a way that the ropes or chains with which they are equipped can be wound without coming off.

Ropes used directly for lifting or supporting the load must not include any splicing other than at their ends. Splicings are, however, tolerated in installations which are intended by design to be modified regularly according to needs of use.

Complete ropes and their endings must have a working coefficient chosen in such a way as to guarantee an adequate level of safety. As a general rule, this coefficient is equal to 5.
Lifting chains must have a working coefficient chosen in such a way as to guarantee an adequate level of safety. As a general rule, this coefficient is equal to 4.
In order to verify that an adequate working coefficient has been attained, the manufacturer or his authorised representative must, for each type of chain and rope used directly for lifting the load and for the rope ends, perform the appropriate tests or have such tests performed.

4.1.2.5. Lifting accessories and their components

Lifting accessories and their components must be sized with due regard to fatigue and ageing processes for a number of operating cycles consistent with their expected life-span as specified in the operating conditions for a given application.
Moreover:

(a)the working coefficient of wire-rope/rope-end combinations must be chosen in such a way as to guarantee an adequate level of safety; this coefficient is, as a general rule, equal to 5. Ropes must not comprise any splices or loops other than at their ends;

(b)where chains with welded links are used, they must be of the short-link type. The working coefficient of chains must be chosen in such a way as to guarantee an adequate level of safety; this coefficient is, as a general rule, equal to 4;

(c)the working coefficient for textile ropes or slings is dependent on the material, method of manufacture, dimensions and use. This coefficient must be chosen in such a way as to guarantee an adequate level of safety; it is, as a general rule, equal to 7, provided the materials used are shown to be of very good quality and the method of manufacture is appropriate to the intended use. Should this not be the case, the coefficient is, as a general rule, set at a higher level in order to secure an equivalent level of safety. Textile ropes and slings must not include any knots, connections or splicing other than at the ends of the sling, except in the case of an endless sling;

(d)all metallic components making up, or used with, a sling must have a working coefficient chosen in such a way as to guarantee an adequate level of safety; this coefficient is, as a general rule, equal to 4;

(e)the maximum working load of a multilegged sling is determined on the basis of the working coefficient of the weakest leg, the number of legs and a reduction factor which depends on the slinging configuration;

(f)in order to verify that an adequate working coefficient has been attained, the manufacturer or his authorised representative must, for each type of component referred to in (a), (b), (c) and (d), perform the appropriate tests or have such tests performed.

BRITISH STANDARD

BS 7906-1:2005

Use of lifting equipment for performance, broadcast and similar applications —

f) Wire ropes used in a performer flying system should have a safety factor of 10. This applies to all operating (lift) ropes and any ropes used to support the system over the performance space. It is recognized that in-view flying wires on which performers are suspended need by their nature to be as thin as possible and may use a lower safety factor provided that the flying wire conforms to BS 7905-1:2001, Clause 9. The safety factor applied should be not less than 5.

BRITISH STANDARD

BS 7905-1:2001

Lifting equipment for performance, broadcast and similar applications —

9.2.2: (Flying of Performers) Supply and Selection

Unless equipment used for performer flying has been specifically designed for that purpose, the components (e.g. flying-bar or shackle) shall be used at no more than 50% of the manufacturers stated SWL

LOLER ACoP Lifting of people

Safe use of lifting equipment
Lifting Operations and Lifting Equipment Regulations 1998

Approved Code of Practice and guidance

Regulation 5 Lifting equipment for lifting persons
Regulation 5(1) Summary

128: If lifting equipment is not marked to indicate that it can be used to lift people, it should only be used if a risk assessment has confirmed it can be used safely and adequate precautions are taken.

Equipment not designed to be used for lifting people should be de-rated by 50%, i.e. have a factor of safety relating to strength of at least twice that required for general lifting operations.

Ontario

Ministry of Labour, Training
and Skills Development

Performer Flying and Aerial Stunts Safety Guideline for the Live Performance Industry in Ontario

Design and construction

1. Equipment should be rated at a minimum breaking strength to load ratio of 10 to 1
2. All structural components should be designed with appropriate safety factors.