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SAFETY CODE FOR DRESS DIVERS IN
CIVIL ENGINEERING WORKS

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INDIAN STANDARDS INSTITUTION
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Indian Standard

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 August 1982, after the draft finalized by the Safety in Construction Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Many works in the field of civil engineering require workmen to carry out their jobs in under-water works, deep foundations and tunnel works, etc. Working in such conditions requires several precautions to be observed to safeguard the workmen against severe hazards to life. IS : 4138-1977* has already been prepared which lays down the safety requirements for work in compressed air under taken in construction works, such as foundations of bridges, docks and tunnels. This standard has been prepared to cover working conditions of dress divers with helmet equipment.

0.2.1 Since in civil engineering works, diving beyond 60 m depth is not required, the provisions of this standard are applicable for diving only up to 60 m depth.

0.3 Adoption of these predetermined safety measures in the diving operations in civil engineering works will not only reduce accidents to the minimum but also promote quicker and risk-free working of the workmen resulting in increased efficiency and thereby effecting overall economy. This standard has, therefore, been formulated with a view to give necessary guidance with regard to safety requirements, to all those entrusted with the execution of diving operations in civil engineering works.

0.4 In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. In this regard, assistance has been taken from the following publication in the preparation of tables for duration of dive and decompression time as specified in **6.1** and **6.2**.

*Safety code for working in compressed air (*first revision*).

**BR 2806 DIVING MANUAL, MINISTRY OF DEFENCE
(NAVY) Her Majesty's Office, LONDON, 1972.**

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the safety aspects relating to diving operations, where divers in the standard diving dress or helmet are employed on works of civil engineering construction and maintenance.

1.1.1 This standard does not cover employment of divers in other operations, such as, exploration of sea bottom, under-water rescue, open sea conditions, etc.

2. PERSONNEL

2.1 Qualifications of Divers — No person shall be employed under-water unless:

- a) he has attained the age of 18 years,
- b) he has been certified as being fit for diving by a qualified medical practitioner within the previous six months. Radiographs of his chest and bones should be taken at not more than 12 months intervals,
- c) before taking up employment he has been satisfactorily tested to the maximum pressure he is to work in diving dress in water or to an equivalent pressure in a compression chamber, and
- d) he has a thorough knowledge of diving signals (*see* Appendix A).

2.1.1 Helmet divers shall be competent in the use of helmet diving equipment. This will include the ability to walk on to a ladder, remain on the ladder for five minutes without interruption of air supply, descend into the water, conduct a circular search in the bottom under conditions of no visibility and in at least 0.6 metre depth of mud or soft silt, work on platform suspended under water, etc.

*Rules for rounding off numerical values (*revised*).

2.2 Diving Supervisor — A competent supervisor shall be present at all times when diving operations are in progress. He shall be familiar with this code and shall take charge of the diving operations. He shall also be fully familiar with the decompression procedures including the ropatic decompression in recompression chamber (*see* IS : 4138-1977*). It is essential that he has previous experience as a diver.

2.2.1 The responsibilities of the supervisor shall include the following:

- a) Ensure that all persons connected with the diving operations under his supervision comply with the requirements of this code,
- b) Allocate duties of the diving crews during diving operations,
- c) Ensure the safety of all personnel under his supervision,
- d) Ensure that sufficient number of signalmen and stand-by divers are present at the site during the whole of the operation, and
- e) Carry physical examination of all the diving equipment personally before each use.

2.3 Responsibility of the Employer

- a) Every employer of workmen undertaking diving operations shall comply with the requirements of this code in so far as they effect any one employed by him,
- b) The employer shall arrange for any medical examination required by the code, and
- c) The divers fitness register containing details of certificates of fitness shall be kept by the employer.

2.4 Signaller — The signaller shall be medically fit and mentally alert. He shall have been certified by competent authority for having knowledge of first aid artificial respiration.

3. SAFEGUARDS

3.1 Where any person is employed under-water as a diver, the following requirements shall be complied with:

- a) A lifeline shall be provided for his use and arrangements shall be made for an effective signalling between the diver and the signal attendant (*see* Appendix A),
- b) Adequate number of competent persons shall be employed in attendance upon him to ensure his safety,

*Safety code for working in compressed air (*first revision*).

- c) A stand-by diver provided with sufficient equipment shall be available to render assistance in emergency. In hazardous conditions, he shall be fully dressed, and
- d) A control point shall be established on the surface before commencement of diving operations.

3.2 A diver shall not be permitted to commence work on empty stomach or within 2 hours of the consumption of a substantial meal. He shall not dive so long as he is under the influence of alcohol or intoxicating drugs consumed by him and if such effects are visible the supervisor shall prohibit him from diving.

3.3 While operating at night two red lights fixed approximately 2 metres apart horizontally and visible all round shall be displayed at the surface control point. While diving operations are in progress whether in day time or in night, no power driven vessel shall be operated and no underwater explosion shall be carried out in the vicinity.

3.4 Diving at an Altitude — If diving operations are carried out at altitude, for example in a mountain lake adjustment shall be made to the decompression schedules to compensate for the surface pressure being less than one bar.

NOTE — Recommended adjustments to be made to the decompression schedules are given below:

- a) Dives between altitudes of 100 to 300 m: Add 25 percent of the depth to calculate the depth of dive,
- b) Dives between altitudes of 300 to 2 000 m: Add 30 percent of the depth to calculate the depth of dive,
- c) Dives between altitudes of 2 000 to 3 000 m: Add 50 percent of the depth to calculate the depth of dive, and
- d) No adjustments are required for altitudes up to 100 m.

3.5 Access — Divers shall not be expected to climb up long vertical ladders with or without their equipment. A light ladder so constructed that it can be angled and can protrude into the water shall be used, as far as possible.

4. EQUIPMENT

4.1 Helmet — The non-return inlet valve through which air from the pump enters the helmet shall be inspected daily. Damage to the screw threads and bearing surfaces are the main points to guard against.

4.1.1 After use, the helmet shall be wiped out, firstly with a cloth dampened in fresh water and then with a dry cloth so as to get rid of salt and dampness.

4.1.2 The visors shall be inspected daily and any cracked ones replaced. Spare glasses shall be maintained at the site.

4.2 Airpipe — Before bringing in use any length of air-pipe, it shall be ensured that it can withstand the intended air pressure with a factor of safety of, at least, two and is composed of materials acceptable for such use.

4.3 Telephone — Divers' telephones have to work under most unfavourable conditions. The helmet is always damp and there is a possibility of moisture entering the telephone diaphragm. Care, attention and gentle handling are essential to maintain reliable communication. All cable connections shall be checked daily to rectify loose connections.

4.4 Ladder — The ladder for getting in and out of the water shall have the railing carried up, at least, one metre above the top rung so that when the diver has his feet on the top rung, he has the support to steady himself.

4.5 Air Pump — The air compressor or pump and the connected system shall be tested daily for leakage and to determine that the pressure can be maintained within the system, at the full working pressure of the dive, after the pump or the compressor has stopped.

4.5.1 A hand pump shall turn, without undue friction, and deliver the required quantum of air against high pressure. The water jackets fitted round the cylinders shall be kept fitted with water to ensure cooling. The water shall be changed as soon as it warms up.

4.5.2 The gauges shall be tested every six months, or earlier whenever an error is suspected.

4.5.3 Power driven compressors should always be used where more than one diver is employed or where continuous diving is called for.

4.5.3.1 The capacity of the compressor shall be such that it can supply at least two divers in the maximum depth envisaged.

4.5.3.2 The compressor shall always supply its air through a receiver, the capacity of which shall be such that the diver can be brought to the surface in safety in the event of a breakdown of the compressor (*see 5.2*). There shall be a separate receiver to supply air to each diver. In addition, it is recommended that the diver carries on his back two cylinders filled with compressed air, which he may avail of for bailing out of water, in the event of failure of air supply from the surface.

4.5.3.3 The intake of the air compressor shall be away from the sources of any smoke or harmful gases and the filter used shall be replaced as and when required.

4.5.4 The air shall be cooled to ambient temperature, dried and filtered to remove any possible impurities and moisture.

4.6 Diving Dress — When in regular use, dresses shall be hung up at night over a jackstay to drain. These shall not be spread out in the sun.

4.6.1 Special care shall be taken when the dress is to be maintained in between uses at long intervals. Any salt shall be washed and the dress dried before storage in a cool place in the dark.

4.6.2 Repairs to the dress shall be promptly carried out according to the manufacturer's instructions.

4.7 Medical Lock — Where the maximum operating depth exceeds 20 m, a suitably constructed medical lock shall be provided and maintained and used solely for the treatment of persons working in compressed air. The medical lock and its use shall conform to the provisions of IS : 4138-1977*.

5. SUPPLY OF AIR

5.1 The air supply shall be fit for respiration and in adequate quantity at a suitable pressure consistent with the depth of working. In order to avoid contamination of air supply, the compressor and cylinders shall be properly maintained at all times. The compressor and the air hoses shall be suited for air used for respiration. Except in an emergency, the compressor designed for industrial use shall not be used for air supply as the efficiency of its filters is inadequate. Hose pipes previously used for industrial purposes shall not be used as these are likely to be contaminated with dirt.

5.2 Air Requirement — The minimum air supply required for a diver, in normal working conditions is 45 litres per minute but may go up to 75 litres per minute in case of hard work. The total air output requirements may be decided by multiplying the diver's requirements by the absolute pressure in bars. For example, hard work at 30 metres depth will require $75 \text{ litres} \times 4 \text{ bars absolute}$, that is, 300 litres per minute of compressor capacity.

6. DECOMPRESSION

6.1 Decompression may be carried out in water or in the medical lock on the surface. When the depth exceeds 10 m, suitable decompression arrangements shall be provided at site. It shall be carried out in accordance with the decompression tables given in IS : 4138-1977* for depths up to 35 m and for greater depths the decompression time shall be calculated by adding 5 minutes to the time for the corresponding depths as given in the table under **6.2**.

*Safety code for working in compressed air (*first revision*).

6.2 Duration of Dive — Up to about 18 m depth, there is no limit placed on the duration of dive. For greater depths, the following may be applied:

<i>Depth (m)</i>	<i>Duration of Time from Leaving Surface to Beginning of Ascent (min): Max</i>	<i>Decompression Time (min)</i>
Up to 18	Normal working hours	35
18-21	95	35
21-24	75	30
24-27	65	35
27-30	55	35
30-33	45	30
33-36	40	35
36-39	35	30
39-42	30	30
42-45	25	30
45-48	25	35
48-51	20	25
51-54	20	30
54-57	20	35
57-60	15	25

APPENDIX A

[*Clauses 2.1(d) and 3.1(a)*]

STANDARD LINE SIGNALS

A-1. A stout long line shall be used for signals. The line shall be laid over the right shoulder of user from the rear and under the left arm clear of all parts of other equipment and the end of the line shall be secured round the belt at the back and over the standing part of the line, so that the user can be pulled out when in difficulties. Various signals shown in Table 1 shall have the meaning as indicated against each:

TABLE 1 STANDARD SIGNALS AND THEIR MEANINGS

(Clause A-1)

SL No.	SIGNAL	MEANING
1.	One pull on the line	User — I am alright, stop lowering me. Attendant — Are you alright? I am stopping lowering you.
2.	Two pulls on the line	User — Pay out more line and lower me further. Attendant — I am paying out more line or I am lowering you.
3.	Three pulls on the line	User — Take in slack line or pull me up. Attendant — I am taking in slack line or I am pulling you up.
4.	Succession of pulls	User — Danger, help me out. Attendant — 'Danger' I am pulling you out.

NOTE — All signals shall be repeated from either end to ensure that these are understood and are being acted upon.