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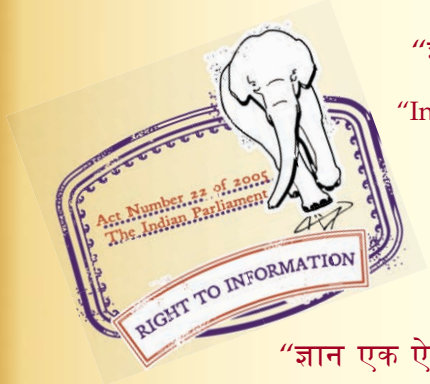

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Indian Standard

GENERAL REQUIREMENTS FOR SILOS FOR GRAIN STORAGE

PART II GRAIN HANDLING EQUIPMENT AND ACCESSORIES

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

November 1970

Indian Standard

GENERAL REQUIREMENTS FOR SILOS FOR GRAIN STORAGE

PART II GRAIN HANDLING EQUIPMENT AND ACCESSORIES

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(*Continued on page* 13)

Indian Standard

GENERAL REQUIREMENTS FOR SILOS FOR GRAIN STORAGE

PART II GRAIN HANDLING EQUIPMENT AND ACCESSORIES

0. FOREWORD

0.1 This Indian Standard (Part II) was adopted by the Indian Standards Institution on 22 December 1969, after the draft finalized by the Storage and Marketing Structures for Agricultural Commodities Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 Handling and storage of grain in structures like silos requires the use of mechanical and electrical equipment, such as elevators and conveyors and accessories, like drying equipment, aeration equipment and fumigation pumps. The mechanical and electrical equipment is generally housed in a head house attached to a silo. Therefore, this standard, covering the requirements for mechanical and electrical equipment and accessories generally used for handling of grain in a silo, has been formulated to assist the planning and construction of silos. It is felt that such a readily available guide would expedite the execution of various silo projects in the country.

0.3 This standard is not intended to restrict the initiative and ingenuity of design and construction engineers.

0.4 In this standard it has been assumed that the work of installation of various equipment would be according to the prevalent codes for installation and, therefore, the engineering practices ordinarily observed in the installation of these equipment have not been covered. However, wherever it has been considered desirable to elaborate on any such practices, care has been taken to include such elaboration in this standard.

0.5 In the formulation of this standard, assistance has been derived from the following publications:

ASA Z 12.4-1953 Code for the prevention of dust explosion in terminal grain elevators. American National Standards Institute.

ASA Z 12.13-1959 Code for the prevention of dust ignitions in country grain elevators. American National Standards Institute.

KETCHUM (M S). The Design of walls, bins and grain elevators. 1929. Ed 3. McGraw-Hill Book Company Inc., New York and London.

GRAIN & FEED JOURNALS CONSOLIDATED. Grain elevators of North America. USA.

0.6 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, 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 (Part II) deals with the important types of mechanical and electrical equipment and accessories used in a silo for handling of grain in bulk. It also prescribes safety precautions to prevent dust explosions and to minimize fire-hazards.

2. TERMINOLOGY

2.0 For the purpose of this standard, the terminology given in IS : 5503 (Part I)-1969† and IS : 4240-1967‡, and the following definitions shall apply.

2.1 Aeration — The process by which a small quantity of air under pressure is moved through grain.

2.2 Drying — A process by which moisture content of grains is reduced.

3. GRAIN HANDLING EQUIPMENT

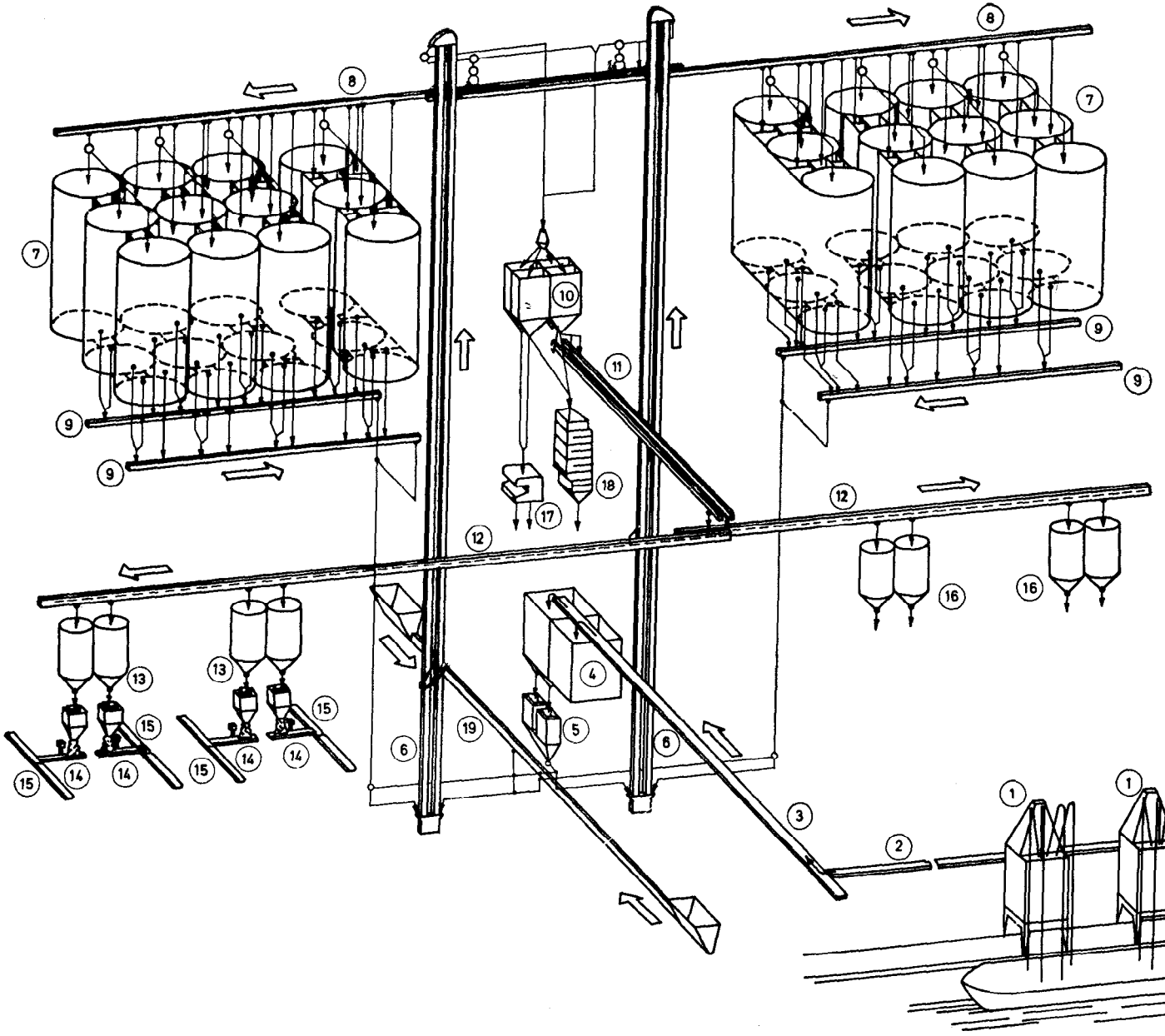
3.0 General — Hoppers, conveyors and elevators form an important unit for receipt, conveying, storage and issue of grains in a silo. The hoppers feed the grain by direct spouting or through conveyors to elevators, which carry the grain to automatic cleaning and weighing machines and finally to the conveyor in the distribution gallery, where the grain is diverted to various bins (*see* Fig. 1).

3.1 Choice of Conveyors — There are various types of conveyors in use, common among them being belt, chain, screw and pneumatic type conveyors. The choice of conveyors depends upon the type of grain to be handled in bulk, type of duty to be performed, distance to be conveyed, handling capacity required, availability of space, number and position of charging and discharging points, and the capital and operating costs. These factors are discussed in the following clauses.

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

†General requirements for silos for grain storage : Part I Constructional requirements.

‡Glossary of conveyor terms and definitions.



REFERENCES

1. Pneumatic discharge (marine tower)
2. Longitudinal conveyor
3. Cross conveyor
4. Garner
5. Automatic weighing equipment
6. Bucket elevator
7. Storage block
8. Distributing conveyors
9. Collecting conveyor
10. Garner for delivery of grains
11. Conveyor for delivery of grains
12. Conveyor for distribution of grains to bagging equipment and bulk despatch
13. Bagging equipment
14. Sewing machine
15. Conveyor for bags
16. Bulk despatch equipment
17. Cleaning equipment
18. Drying equipment
19. Conveyor for grain-intake from lorries and rail cars

FIG. 1 A TYPICAL GRAIN FLOW DIAGRAM

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3.1.1 *Type of Duty Performed* — All type of conveyors, such as belt, screw, chain, or pneumatic may be used for horizontal straight conveying. The belt conveyor may be worked up to an inclination of 15° to the horizontal. The screw conveyor may be worked at an inclination, but the capacity would be reduced proportionately to the degree of inclination; an inclination at 15° and 25° may reduce the capacity to 70 and 40 percent respectively. For stiff inclination the helix should have a short pitch and the trough may be made tubular. Chain designed may be worked at any inclination and even in vertical positions restricted to 45°. The pneumatic conveyor may be worked for horizontal, vertical and inclined conveying. Where permanent installations of conveyors are desired, it would be advisable to select belt, screw or chain conveyors. If, however, the position of receiving and discharging points vary, consideration may be given to pneumatic or portable type of conveyors. The drive may be by electric motor or by petrol or diesel engine, if electricity is not available.

3.1.2 *Distance to be Conveyed* — Belt conveyors may be employed for conveying on long distances. Screw conveyors may be restricted to distances up to 30 to 40 metres. In case of the chain conveyors, the distance depends upon the tensile strength of the chain, and is normally less than 30 metres. The capacity of pneumatic conveyors falls rapidly with increase in distance, and its use for distances over 50 metres should be carefully considered.

3.1.3 *Handling Capacity Required* — For small handling capacities up to about 80 tonnes per hour, screw conveyors may be used. For high handling capacity, the belt chain or pneumatic conveyor may be used. In the latter case, the belt conveyors may be used up to capacity of about 200 tonnes per hour. For higher handling capacities, a number of conveyor units may be used.

3.1.4 *Availability of Space* — Where the space available is limited, the use of screw, chain, or pneumatic conveyors may be considered, whereas, if sufficient space is available, the use of belt conveyors may be considered.

3.1.5 *Number and Position of Charging and Discharging Points* — In the case of belt, chain, and screw conveyors, the charging and discharging may be done at several points, while in case of pneumatic conveyors, the charging and discharging points are normally at one place, which may be shifted from place to place.

3.1.6 *Capital and Operating Cost* — The belt conveyor is the most economical, since running expenditure is less compared to other type of conveyors. The screw conveyor is more expensive than belt conveyor. The initial cost is higher in case of chain conveyors, which also need more of the running and maintenance cost. The initial cost, running and maintenance expenditure are the highest in case of pneumatic conveyors.

3.2 Elevators — Generally, separate elevators should be employed for receipt and issue of grain into and from the bins or other storage structures. Elevator has a leg with boot for receiving the grain at the bottom and elevator head for discharging the grain at the top. The bucket type of elevator is the most common, and is quite economical and efficient with the least running and maintenance expenditure. The buckets carrying the grain may be made of mild steel, and may be either carried on a chain or a flat belt of synthetic textile and rubber.

3.2.1 The bucket elevators may be self-supporting type to sustain all working loads and self weight unless installed in a head house, where they shall be adequately supported.

3.2.2 Leg casings and connecting spouts shall be dust-tight.

3.2.3 The elevator boots shall be above the floor rather than in pits and be provided with adequate clean-out doors. However, if the pits are necessary, ample room shall be provided for cleaning, oiling and repairing boots. Pits shall be adequately lighted with fixed lights and be accessible by permanent iron ladder or stairway.

3.2.3.1 The elevator boots shall be so constructed as to minimize the probability of chokes and be provided with covered hoppers into which spill and clean-up can be shovelled back into the boot.

3.3 Layout of Conveyors — While considering the layout of the different type of conveyors, it is advisable to find the shortest course with minimum possible bends. The free flow of the grain from one conveyor to the other, or to the portions where gravity flow is made, should be given consideration. All possible restrictions and choking points should be considered and layout for a smooth flow should be decided. It is necessary that all gravity flows through spouting shall have adequate cross-sections and suitable inclinations with the horizontal. Hoppers or garners should be introduced wherever there is possibility of accumulation of grain in the flow.

3.4 Requirements for Installations

3.4.1 All structural members, whether of reinforced cement concrete or steel or of any other construction, employed in conveyors, as well as those supporting them shall have adequate strength, considering all static and dynamic loads to which they may be subjected.

3.4.2 The belt conveyors [*see* IS : 1891 (Part I) - 1968 *] and bucket elevators shall have tensioning arrangement of the screw type or of the gravity type.

3.4.3 All the parts of the installations shall be accessible for maintenance and inspection.

*Rubber conveyors and elevator belting: Part I General purpose belting (*first revision*).

3.4.4 There shall be sufficient space all round the machinery and also clear head-room for working purpose.

4. ACCESSORIES

4.0 General — Besides the main handling equipment as given in **3**, cleaning machines, drying equipment, aeration fans, fumigations pumps, manlift and temperature detecting devices form essential accessories to the handling equipment.

4.1 Cleaning Machines — The grain brought from field may contain a variety of foreign materials, like straw, insects, stones and dust. Cleaning machines should generally be employed to clean the grain by sieving and should be connected with large dust collectors, which remove the dust by suction. Overall capacity of the cleaning machines may match the capacity of the elevators.

4.1.1 All cleaning, or other grain processing machinery shall be of non-combustible construction.

4.2 Drying Equipment — Grain with more than 14 percent moisture is not recommended for storage in silo. When the grain with high amount of moisture is received, it shall be dried either in sun or, if the moisture content of grain is high, drier should be used. The drying equipment should be generally housed in a drier house attached to a silo. It may consist of a chamber in which the grain should be allowed to fall in a zigzag fashion through baffles placed in a line and hot air blown from the sides of the chamber. It may be a continuous process allowing the grain to pass through it several times depending upon the amount of moisture to be removed.

4.3 Temperature Detection Equipment — The deterioration of grain is shown by development of hot spots at different places in a bin. It is, therefore, necessary to provide for a temperature detection equipment in order to detect any rise in temperature at different points and pitch. The system shall consist of temperature sensing devices placed vertically inside the bins from bottom to top at vertical intervals of 1·5 m. At least one sensing device should be provided for a radius of 3 metres in the horizontal plane. The device shall be connected by cables and led to reading instruments suitably located outside the bins. The cable insulation inside the bin shall be resistant to abrasions, moisture and chemicals.

4.4 Aeration Equipment — The grain in storage may require periodical aeration to keep it in satisfactory condition to prevent increase in temperature and development of hot spots on grains. The process may consist of blowing air through grain either from below or from above. The floor of the bin should be perforated and the chamber below the floor be used as a plenum. Alternatively, air may be blown through a tunnel having a number of ducts leading to all directions at the floor level, or aeration vents

may be provided to hopper-bottom bins. The net area of perforations may normally be about 15 percent of the gross floor area. The air required for aeration shall be roughly calculated on the basis of 75 ml/litre/minute.

4.5 Fumigation Pumps — Fumigation of stored grain may be necessary to protect it from insects. Fumigation of grain may be done either by tablets, which may be placed on the conveyor and carried to a bin, or by liquid fumigants. For use of liquid fumigants, a fumigation pump for spraying the liquid fumigant over the entire top surface of the stored grain isnecessary. A galvanized iron pipe of 12·5 mm diameter and fitted with a number of spray-nozzles should be fixed below the ceiling of the bin. A pump should be connected to the pipe outside the bin. To develop necessary pressure required for spraying, a reciprocating pump should be used which may be driven by an electric motor or by a diesel or petrol engine. The pump may be of a portable type and may be shifted from one bin to the other for fumigation purpose. The pump cylinder, piston and other accessories required in this operation shall be corrosion resistant. Aeration equipment may be suitably modified to convert it into recirculation system for effective fumigation and economical considerations.

4.6 Weighing and Bagging Machines — It is necessary to have arrangements of weighing machines for weighing incoming grain, in the head house. They may generally be installed close to cleaning machines so that the cleaned grain may be weighed before storage. Weighing machines may also be installed at the issue point. Similarly, bagging and stitching machines may also be installed in the silo.

4.7 Man Lift — Normally, the mechanical and electrical installations and the accessories of silo require frequent trips of staff for maintenance, repairs and inspections. An electrically operated man lift with a capacity of two to three passengers may be necessary. The lift shall be installed in the head house which should go up to the last stage of the head house.

4.8 Telephone — In a silo installation, where a number of conveyors work in a line, it is frequently required to be communicated from a control room with the staff posted at different stations. For this purpose an internal telephone exchange is considered necessary. However, where, for economic considerations, provision of telephone may be considered difficult, a system of sounding hooters or sirens may be arranged. This may help to warn people to be on the guard as the conveyors and other equipment, on which they are working, are started. The telephone may also be necessary for calling outside help in emergency.

4.9 Fire-Fighting Equipment — It is necessary to provide for fire-fighting equipment in a silo. Selection of the equipment depends upon the type of conveyors to be handled. Arrangement of right type of fire extinguishers should be made (*see* IS : 3594-1967*). It may be advisable to have

*Code of practice for fire safety of industrial buildings: General storage and warehousing including cold storages.

provision of one or two types of fire extinguishers supplemented by fire-hydrants running throughout the area of the silo. The following information may be useful in selecting the right type of fire extinguishers (*see* IS : 1641-1960*, IS : 1648-1961† and IS : 2190-1962‡):

Material	*Fire Extinguishers*
Paper, wood, rubber and general articles requiring cooling and quenching	Soda-acid and foam type extinguishers
Burning liquid, such as gasoline, paint, oil or grease, requiring smothering for quick extinguishment	Carbon dioxide, as also chemical type extinguishers or foam type extinguishers
Live electric wires from motors, electric appliances, etc, where non-conducting extinguishing agent is needed	Carbon dioxide, as also chemical type extinguishers

4.10 Control Room — A large silo installation, where the grain is handled by a number of conveyors working in a line, requires provision of a control room, suitably located with an illuminated board by which the flow of the grain taking place at any time in a particular way, can be reflected on a panel. It is also called a ' mimic indicator ' and is especially necessary when there are a number of silo bins to be filled or emptied simultaneously, so that the control room operator would have full control over the machines. An automatic audio-visual bin-level indicator may also be considered as a good adjunct to a silo installation.

4.11 Safety Precautions — Safety precautions in regard to the dust pollution and operation of various mechanical and electrical equipment, described above, shall be observed strictly, and inspection and necessary cleaning of the whole structure shall be carried out periodically to avoid fire-hazard, explosions and other accidents, which may result in loss of valuable grain, equipment and human life. The following safety precautions shall be observed.

4.11.1 *Dust Pollution of Atmosphere and Dust Explosion* — High concentration of dust in air may catch a spark or fire at any place and may cause simultaneous ignition of particles and finally an explosion. Hence, it is important that dust should, as far as possible, be kept under control.

*Code of practice for fire safety of buildings (general): General principles of fire grading.

†Code of practice for fire safety of buildings (general) : Fire-fighting equipment and its maintenance including construction and installation of fireproof doors.

‡Code of practice for selection, installation and maintenance of portable first-aid fire appliances.

4.11.1.1 All feeding and discharging points where dust is likely to be raised, aspirators with dust catching cyclones shall be provided in order to minimize the nuisance.

4.11.1.2 The area all round the machinery and the conveyors shall be kept clean.

4.11.2 All electrical wirings, fittings, fixtures and electric drive motors installed in dust-laden atmosphere, except in the open and in offices and similar locations so occupied and segregated as to be reasonably free from dust, shall be flame-proof. In case of electric motors installed in open, the same may be of totally enclosed type.

4.11.3 Trailing cables of all portable type of conveyors shall be closed by flexible metal conduits throughout and rigidly fixed at both ends. All portable motors shall be connected to two distinct earths.

4.11.4 All fast moving parts of the installation shall be protected by guards or covers, while the running belt of a belt conveyor need not be provided any protection. All bucket elevators shall be provided, wherever necessary, with automatic back-stop arrangement, so that in case of power failure during the full load, running of the elevator in the reverse would not be possible.

4.11.5 All elevators shall be equipped with an automatic mechanical or electrical tamper-proof device to shut off driving power leg, in case leg belt slows down. An interlocking device should simultaneously shut off power on all contributory screw or belt conveyors which feed the elevators.

4.11.6 The possibility of a choke-up arises when the grain flows in a number of conveyors in line. It is, therefore, essential that all the conveyors working in a line shall be interlocked so that the stoppage of any one but the first conveyor will make all the conveyors after it, inoperative.

4.11.7 A distinctive alarm or signal shall notify operator in case of shut down.

4.11.8 Spouts introducing grain into bins shall be arranged, where possible, to prevent grain stream striking the side of bin on account of the possibility of tramp iron striking a spark on contact with side.

4.11.9 Boards prohibiting smoking and use of naked lights shall be fixed at all prominent places in the area of silo installation.

4.11.10 Adequate hygienic precautions shall be taken for handling grains in all types of conveyors.

4.11.11 Protection against lightning shall be provided in accordance with IS : 2309-1969*.

*Code of practice for the protection of buildings and allied structures against lightning (*first revision*).

4.11.12 In case the silo is located near airways, the aviation obstruction lights shall be provided in accordance with the Civil Aviation Standards.

4.11.13 While handling fumigants, precautions as prescribed by the suppliers and manufacturers shall be exercised.

4.11.14 Workers shall be provided with masks, when they have to work in a dust-polluted air.

4.11.15 Staff and workers shall also be provided with industrial safety helmets (*see* IS : 2925-1964*).

4.11.16 Main storage of lubricating oil and grease shall be outside. Storage of lubricating oil and grease in the head house shall be limited to a maximum of 5 barrels and shall be in an oil-room of non-combustible construction.

4.11.17 Lift installations shall be in accordance with the Indian Lift Act.

*Specification for industrial safety helmets.

(*Continued from page* 2)

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