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भारतीय मानक मसौदा

जड़ और कंद प्रकार की सब्जी के लिए धुलाई उपकरण — सतत प्रकार —
विशिष्ट और परीक्षण कोड

Draft Indian Standard

**ROOT AND TUBER VEGETABLE WASHER — CONTINUOUS TYPE —
SPECIFICATION AND TEST CODE**

ICS 65.060

Agriculture and Food Processing Equipment
Sectional Committee, FAD 20

Last date of comments: **3 June 2024**

FOREWORD

(Formal clauses will be added later)

Many root and tuber vegetables, like carrots, radish, beet root, cassava are categorized as ground vegetables, growing beneath the soil's surface. Upon harvest, they bear soil and debris, necessitating thorough washing prior to consumption or transportation. This cleansing process ensures food safety and hygiene standards are met, maintaining the integrity of the produce.

These vegetables are harvested either manually or mechanically and get easily contaminated with microbes, physical damage, cracking cuts, bruising, *etc.* These cannot be stored along with soil for a long time and it is necessary to wash off the mud and dirt particles which would increase the physical appeal in the market and also aid in further processing. Traditional method of washing root and tuber vegetables is by trampling under feet in running water like streams and also in washing yards. This not only damages the product but also results in contamination because it is constantly rubbed with the feet. The operation requires more labour and the labourers are constantly exposed to cold water during the washing operation. Soaking in still or moving water is effective only if dirt or other undesirable matter is present in small quantities and is loosely attached to the product. So there is a need for an efficient washer to remove the mud and other foreign matter present on the surface of root and tuber vegetables as adequate cleaning is a critical operation in the production and distribution of root vegetable vegetables.

For proper washing, an equipment capable of efficiently cleaning the root and tuber vegetables should be used. Therefore, to improve and standardize the design and better adaptation of the vegetable washing equipment to the requirements of the users, BIS has taken up formulation of standard on the subject.

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: 2022 'Rules for rounding off numerical values (*second revision*)'. 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

This standard specifies the material, constructional, performance, and other requirements of continuous type root and tuber vegetable washer. It also prescribes the test method for evaluating the performance of this equipment.

2 REFERENCES

The following Indian Standards contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All these standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated:

<i>IS No.</i>	<i>Title</i>
IS 210: 2009	Grey iron castings — Specification (<i>fifth revision</i>)
IS 277: 2018	Galvanized steel strips and sheets (plain and corrugated) —Specification (<i>seventh revision</i>).
IS 399 : 1963	Classification of commercial timbers and their zonal distribution (<i>first revision</i>)
IS 816: 1969	Code of practice for use of metal arc welding for general construction in mild steel (<i>first revision</i>)
IS 2062: 2011	Hot rolled medium and high tensile structural steel — Specification (<i>seventh revision</i>)
IS 6911 : 2017	Stainless steel plate, sheet and strip — Specification (<i>second revision</i>)

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Broken or Bruised Vegetable — Damaged/broken/bruised vegetable collected from the outlet of the equipment for washed vegetables after washing.

3.2 Cleaned Vegetable — Vegetable free of small fibrous roots after washing.

3.3 Extraneous Matter — Organic/inorganic material comprising of dirt, gravel, small stones/pebbles, lumps of earth, clay, mud, etc.

3.4 Mechanical Washing Efficiency — Washed vegetable (after removal of dirt, soil, mud etc.) received at the outlet of the equipment for washed vegetables with respect to the total vegetable (un-cleaned) fed at the inlet expressed as percentage by mass.

3.5 Microbial Washing Efficiency — The difference in microbial load of the vegetable before and after washing, expressed as a percentage calculated based on the microbial load before washing.

3.6 Output Capacity — The total mass of the vegetable collected at the equipment main outlet per unit time.

3.7 Percent Damage — The broken/damaged vegetable collected from the outlet with respect to total input of vegetable expressed as percentage by mass.

3.8 Percentage of Uncleaned Vegetable — The unclean vegetable (with fibrous roots) collected from outlet with respect to the vegetable fed at the inlet expressed as percentage by mass.

3.9 Percentage of Unwashed Vegetable — The unwashed or partially washed vegetable collected from outlet with respect to total vegetable input expressed in percentage by mass.

3.10 Sample — The quantity of vegetable taken from the outlet at a particular time period.

3.11 Washed Vegetable — Vegetable free of extraneous matter viz., soil, mud, dirt, etc. after washing.

4 MATERIAL

The material used for various components of this continuous type tuber vegetable washer shall be as given in Table 1. However, the use of stainless steel in place of cast iron or mild steel wherever found suitable is preferred.

Table 1 Material of Construction
(Clause 4)

Sl. No. (1)	Component (2)	Material (3)	Reference to IS (4)
1.	Bearing housing/plummer block	Cast iron	IS 210
2.	Bottom and top drum of Elevator	Cast iron	IS 210
3.	Elevator body/frame	Mild steel	IS 2062
		Stainless steel	IS 6911
		wood	IS 399
4.	Feed hopper/feeding system	Mild steel	IS 2062
		Stainless steel	IS 6911
5.	Feed roll	Cast iron	IS 210
6.	Feed rate/distribution plates	Mild steel	IS 2062
		Stainless steel	IS 6911
7.	Main frame	Mild steel	IS 2062
		Galvanized iron	IS 277
		Stainless steel	IS 6911
8.	Hand wheels/adjustment levers	Cast iron	IS 210
		Mild steel	Grade A of IS 2062
		Stainless steel	IS 6911
9.	Pulley	Cast iron	IS 210
		Mild steel	Grade A of IS 2062
10.	Washing chamber/drum	Mild steel	Grade A of IS 2062
		Galvanized iron	IS 277
		Stainless steel	IS 6911
11.	Shafts	Mild steel	IS 2062

5 CONSTRUCTIONAL REQUIREMENTS

5.1 Chain Conveyor

Conveying system made of non-rusting/corrosive material or with protective coating shall be provided for continuous feeding of vegetables for washing. Above the conveying system, water shall be sprinkled/spayed using nozzles/jets. The water and mud shall be passed through the conveyor system without stagnation. The size and length should be proportional to the capacity and as per the manufacturer's design.

5.2 Feeding of Vegetables

The washer shall be provided with appropriate feeding arrangement, viz., elevator/conveyor to facilitate easy feeding of vegetables for washing. Also the conveying systems shall not damage the vegetables.

5.3 Frame

The frame shall have provision to install the washer on a level floor for vibration free operation.

5.4 Hopper

The hopper shall be made of minimum 1 mm thick sheet and shall be provided with slope for easy flow of the vegetables.

5.5 Outlet for Mud/Soil

Outlet(s) for collection and safe disposal of used water and mud/soil shall be provided.

5.6 Outlet for Washed Vegetables

Outlet(s) at appropriate height shall be provided for removal or collection of washed vegetables from the washer.

5.7 Prime Mover and Installation

The unit may be provided with provision to mount on level floor and operated with electric motor/diesel engine/tractor power take off (PTO).

5.8 Rotary Screen

One or multiple perforated rotary screens depending on the capacity of the washer shall be used and these shall rotate either clockwise or counterclockwise as per the manufacturer's design. The speed of rotation and inclination of the cylinder(s) may be fixed or variable to accommodate various types of vegetables.

5.9 Shafts

The shafts shall be supported with suitable sealed bearings and housings on the stable part of equipment.

5.10 Transmission Drive

A suitable drive system like geared motor or sprocket chain or V belt pulley system for transmitting the power

to the washing chamber or conveyor shall be provided in the vegetable washer.

5.10.1 Suitable transmission guards shall be provided to prevent accidents due to contact with moving part of the equipment with human beings while in operation. The guards shall not hinder the operations of the equipment while making adjustments available in the equipment.

5.10.2 It is preferable that all the guards shall be either permanently attached or firmly secured to prevent its removal without aid or tools. The servicing and adjustment should be possible without removal of the guards.

5.10.3 The guards shall have sufficient strength to support load at any point during the operation.

5.11 Water Supply

Adequate quantity of clean water shall be supplied to the washer through pipe lines of adequate size and shall be able to withstand the water pressure. Appropriate distribution system/nozzles/jets shall be provided with the flow and pressure regulating system.

6 PERFORMANCE REQUIREMENTS

6.1 During the no load run, visual observation shall not show the following:

- a) Presence of any marked vibrations during operation.
- b) Presence of undue knocking or rattling sound.
- c) Frequency slippage of belts/chains.
- d) Non-smooth running of shafts in the bearing housings.
- e) Any marked wear or slackness in any components.
- f) Any marked rise in temperature of operational bearings and its housing.
- g) Leakage in water supply for washing.
- h) Leakage in removal of used water and mud.
- j) No mechanical damage to any components of the washer.

6.2 The rated input capacity in quintals per kWh energy consumed shall be declared by the manufacturer. The various adjustments, clearances and speeds for that capacity shall also be declared. When tested in accordance with the method given in clause **10.4.3.5**, the declared capacity shall not differ by ± 5 percent.

6.3 The quantity of water required to wash the vegetables completely for each vegetable determined as per clause **10.4.3.4** shall be expressed as litre/tonne of vegetable, this shall not differ by ± 5 percent of the manufacturer's recommendation.

6.4 The mechanical washing efficiency and microbial washing efficiency, determined as per clause **10.4.3.2 (a)** and **10.4.3.2 (b)** shall be not less than 80 % and 85 %, respectively. Also the same shall not differ by ± 5 percent of the manufacturer's recommendation.

6.5 The percentage bruising caused to the vegetables during washing should be minimum and shall not exceed 5 %.

6.6 During and after the capacity test, the visual observation shall not indicate the following:

- a) Observations given under **6.1 (a)** to **(j)**;

- b) Frequent clogging of outlets for washed vegetables, water, soil/mud, *etc.*;
- c) Non-smooth flowing of material through different components;
- d) Frequent clogging in the flow of vegetables; and
- e) Leakage of vegetables, water and soil/mud from the washer, while in operation.

6.7 When tested in accordance with clause **10.4.3**, no breakdown shall occur in any units/components of the washer.

7 OTHER REQUIREMENTS

7.1 Provision for tightening belts/chains/sprockets shall be provided.

7.2 Arrangement for lubrication of bearings and other moving parts as required shall be provided.

7.3 Provision for easy transportation or towing with tractor shall be provided. Loading lugs shall also be provided for easily lifting of equipment.

7.4 The washer shall be provided with operator's manual/service manual.

7.5 Provision for changing/adjusting of the following shall be made:

- a) Feed rate
- b) Water flow rate
- c) Speed of washing chamber
- d) Slope of washing chamber

7.6 Provision for cleaning the perforations to avoid clogging shall be provided.

7.7 Suitable inspection window may be provided to inspect the process of washing, in case of a closed system.

8 WORKMANSHIP AND FINISH

8.1 Welding used for joining components shall not be porous. For mild steel components, welding should be done as per IS 816.

8.2 Any sharp corners and protruding fasteners shall be avoided or made smooth.

8.3 Components shall be free from cracks, pits, burrs and other visual defects which may be detrimental for its use.

8.4 All the components of equipment shall be made with rust/corrosion resistant materials or provided with preventive coating or painted with quality paints.

9 MARKING AND PACKING

9.1 Marking

Each washer shall be marked with the following particulars:

- a) Manufacturer's name, address and their recognized trade-mark if any;
- b) Batch or code number;
- c) Power rating and capacity;
- d) Model No.; and
- f) Year of manufacturing;

9.2 A minimum cautionary notice worded as follows shall be written in vernacular language legibly and prominently on the main body of the vegetable washer:

- a) Do not wear loose dress, bangles, watch, *etc*, while working;
- b) Persons with long hair shall be prevented to work closer to the moving parts, unless wearing a hair net;
- c) Do not work under the influence of intoxicants like liquor, opium, *etc*;
- d) Children and aged persons shall be discouraged for working on vegetable washer;
- e) Do not cross over moving belts;
- f) Do not operate washer without guards and safety devices;
- g) Do not make adjustments when washer is working, unless recommended or specified; and
- h) Do not put or take-off belt while pulley is running.

9.3 BIS Certification Marking — The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

9.4 Packing — The washer shall be packed for safety and security of human being while in transit and as agreed to between the purchaser and supplier for safe handling in transit.

10 METHODS OF TEST

10.1 Selection of The Washer and Test Material

Following the standard sampling procedure, one vegetable washer shall be selected from the production lot in mutual agreement with the manufacturer for the test. Sufficient quantity of tuber and root vegetable for testing the washer shall be taken immediately after harvesting along with mud/soil. Well matured vegetables which are free from bruises, damage, cut, *etc* shall be taken as test material.

10.2 Running-In and Preliminary Adjustments

10.2.1 The vegetable washer shall be installed on a level and preferably on a hard surface with anti-vibration mount/concrete foundation. All the adjustments shall be made in accordance with the manufacturer's recommendation and the water supply shall be provided along with drainage facilities.

10.2.2 The washer shall be attached with a suitable prime mover, preferably with an electric motor and auto-voltage stabilizer or diesel engine/power take off (PTO) of tractor. An energy meter or some form of transmission dynamometer shall be fitted. The power delivered to the washer may be supplied in the following ways:

- a) Direct coupling the prime mover with the main shaft of the washer.
- b) Connecting the prime mover with the help of a flat or V-belt and pulleys with the washer's main shaft.

10.2.2.1 In the case of (a), the power delivered to the vegetable washer would be the power output of the prime mover, whereas, in the case of (b), the allowances for flat and V-belt drive losses may be taken at 6 percent and 3 percent, respectively.

10.2.2.2 In case of diesel engine/tractor PTO operated, provision shall be made for measuring the fuel (diesel) consumption in liters with respect to time.

10.2.3 The washer shall be run-in without load before commencing the tests. The running-in shall be carried out in accordance with the manufacturer's recommendation. In the absence of any recommendation by the manufacturer, the washer shall be run-in for 30 minutes. During the period of the run-in, adjustments for various functional components may be done. All the adjustments done shall be in accordance with the instructions contained in the manual supplied by the manufacturer.

10.3 Pre-Test Observations

10.3.1 *Determination of Foreign Matter* — The foreign matter (dirt, soil, mud, microbial load, etc.) present in the vegetable to be cleaned shall be determined in accordance with clause **10.4.3.2 (a)** for the estimation of the mechanical washing efficiency and microbial washing efficiency.

10.3.2 *Determination of Microbial Load on The Surface of Vegetables* — The microbial load present in the surface of the vegetable shall be determined in accordance with clause **10.4.3.2 (b)** by total plate count (colony forming units, cfu) following serial dilution technique for the estimation of the microbial washing efficiency.

10.4 Type Test

10.4.1 General Tests

10.4.1.1 *Checking of Specifications* — The specifications given by the manufacturer shall be checked and reported in the proforma as given in Annex A.

10.4.1.2 *Checking of Material* — The material of construction of all the components of the washer shall be reported in the data sheet given in Annex B.

10.4.1.3 *Visual Observations and Checking of Provision for Adjustments* — The observations and adjustments given in data sheet in Annex C shall be made and reported.

10.4.2 Test at No Load

10.4.2.1 After the running-in, the vegetable washer shall be run at no load for 30 min. at the speed specified by the manufacturer. During and after the no-load run, the visual observation of the washer shall not show any failure as given in **6.1 (a) to (j)**.

10.4.2.2 Also, record the readings of the energy meter/fuel consumed. Calculate the power/fuel consumption at no-load after the procedure given in clause **10.4.3.3** which shall be recorded in Annex D.

10.4.3 Test at Load

10.4.3.1 Operation and Collection of Data — The vegetable washer shall be operated at its specified speed for 30 min at the feed rate specified by the manufacturer and data shall be recorded as per Annex E. During the run period, collect the following samples and data:

- a) Weigh adequate quantity of raw materials (harvested vegetable with mud/soil) to operate the washer for 30 min.
- b) Three sets of samples, about 2 to 5 kg, in the washer at feed and washed vegetable outlet shall be taken at an interval of 10 min at each outlet.
- c) The main shaft's speed and the reading of the energy meter or dynamometer or fuel consumption, shall be recorded.
- d) During the test, measure the quantity of water supplied for washing purpose, using a water flow meter/estimated from the time taken for filling a container of known volume.
- e) Operate the washer for 30 minutes and record the time.
- f) At the end of 30 min. feeding, run the washer for some time to practically no more material already fed comes out. At the end of the test, weigh the material collected through the outlet for the washed vegetables.
- g) This test shall be repeated for a minimum of three times at various feed rates covering approximately 90 percent, 100 percent and 110 percent of rated input capacity declared by the manufacturer.

10.4.3.2 Sample Preparation and Analysis — Following parameters shall be determined and data shall be recorded suitably in Annex F and Annex G.

a) *Mechanical washing efficiency* — Washing of vegetables for removal of soil/mud, in a mechanical washer is indicated by mechanical washing efficiency. From the feed, a known mass of weighed vegetable (about 100 g) shall be thoroughly washed using 500 ml of distilled water. The glass beaker with water is evaporated in a water bath. After evaporating all water, the beaker shall be dried in an oven at 130°C for 1 hour and the final mass of beaker shall be measured and from the empty weight of the beaker, the mass of the soil/mud shall be estimated. Similarly from the samples collected at washed vegetable outlet (100 g), the mass of soil/mud present after washing shall be estimated by washing in 500 ml of distilled water. From the mass of soil/mud present in vegetable before and after washing, the mechanical washing efficiency shall be calculated as:

$$\text{Mechanical washing efficiency, \%} = [(W_{uw} - W_w)/W_{uw}] 100$$

where,

W_{uw} = weight of soil/mud present in 100 g of unwashed vegetable, g, and

W_w = weight of soil/mud present in 100 g of washed vegetable, g.

b) *Microbial washing efficiency* — The samples taken before and after washing of vegetable shall be analyzed for total plate count (colony forming units, cfu) by serial dilution technique. A sample of 5 g shall be aseptically

cut from un-washed and washed samples and macerated with 45 ml distilled water (0.1%) in a sterile glass mortar and then serially diluted up to 5 dilution (1:5) per sample. Tryptone glucose agar shall be made by mixing 24 g in 1000 ml of distilled water. One ml of suitable dilutions shall be pour plated on tryptone glucose agar and plates were incubated at 37 °C for 36-38 h. All samples shall be analyzed in duplicates and results were expressed as colony forming unit per gram (cfu/g) of sample. For analysis five-fold dilution series of sample may be prepared. The microbial washing efficiency shall be calculated as given below:

$$\text{Microbial washing efficiency, \%} = [(I_{ml} - F_{ml})/I_{ml}] / 100$$

where,

I_{ml} = initial microbial load, cfu/g, and

F_{ml} = final microbial load, cfu/g.

c) *Percentage bruising* — Bruised vegetables means those with some damage occur or in which the outer most tissues of the sample came out or bruised simply means skin came out which might be due to either by striking with sample itself or due to rubbing action while being conveyed in the washing chamber. It is the ratio of weight of bruised sample after washing to the total weight of the sample, expressed in percentage. Take about 5 kg of samples after washing. Separate the bruised samples and weigh them.

$$\text{Bruising percentage, \%} = (W_{bs}/W_{ts}) 100$$

where,

W_{bs} = weight of bruised sample, kg

W_{ts} = total weight of sample after washing, kg.

d) *Retention time* — The time for the particular sample remain inside the washing chamber or it is time when the sample was fed from the feed inlet to the time when it comes out through the outlet. For calculating the retention time, one sample from each root vegetable shall be taken with a mark made permanently by making cut in some portion of the sample for identification at the outlet and the corresponding time taken for the sample to pass through the washing chamber.

10.4.3.3 Determination of Energy/Fuel Consumption — The energy requirement for each feed rate shall be calculated in accordance with following:

a) In the case of prime mover fitted with an energy meter, the readings taken shall be the energy consumption for 5 min. The energy consumption per hour, giving due allowance to the type of drive, shall be calculated and reported.

b) In the case of prime mover fitted with the dynamometer, the readings taken shall indicate the torque required. The energy consumption giving due allowance to the type of drive (*see 10.2.2.1*) shall be determined after computing power delivered by prime mover by the following formula:

$$P = \frac{(T \times s)}{9549.3}$$

where,

P = power delivered by the prime mover, kW;
 T = torque, Nm; and
 s = speed, rev/min.

c) In the case of diesel operated prime mover, the diesel consumed over the noted time shall be expressed in litre of diesel consumed/hour.

10.4.3.4 Water Requirement in Washing — From the quantity of water delivered for washing the known quantity of vegetables, the water requirement shall be estimated and expressed as litre of water per tonne of vegetables.

10.4.3.5 Determination of The Rated Input Capacity — Select the feed rate as suggested by the manufacturer for various root and tuber vegetables at which the following requirements are met. The capacity in terms of energy consumed shall be calculated by dividing the capacity by the energy consumed (*see 10.4.3.3*).

It shall be able to remove 80 percent of the soil/mud and 85 percent of the microbial load (estimated as cfu/g) from the vegetables with less than 5 percent-of bruising in one pass. The capacity shall be calculated from the quantity of the vegetables cleaned and the respective time taken as,

$$\text{Capacity, kg/h} = \frac{(\text{Quantity of the vegetables washed (kg)})}{(\text{Time taken in min.})} \times 60$$

10.5 Routine Test — Visual observations and checking of provision for adjustments (*see 7.5*), and test at no-load (*see 10.4.2*) shall be checked.

11 LONG RUN TEST

The washer shall be operated for a minimum of 20 h at load, which could be covered by a continuous run of at least 5 h and data shall be recorded in Annex H. During and after the operation, no breakdown or defect shall develop in the vegetable washer.

12 SUMMARY REPORT

For the guidance of the user, compile a summary report on the proforma as given in Annex J.

ANNEX A
(Clause 10.4.1.1)

SPECIFICATION SHEET

To BE FILLED IN BY

Manufacturer

Testing Station

A-1 General

- a) Make :
- b) Model :
- c) Year of manufacture :
- d) Name and address of manufacturer :

A-2 Power Unit

- a) Type of prime mover :
- b) Number of prime mover :
- c) Recommended power, kW (hp) :
- d) Type of drive :

A-3 Suitability of Vegetables

- a) Main vegetable :
- b) Other vegetables :

A-4 Main Drive

- a) Type :
- b) Directly coupled :
- c) Belt drive :
- d) Chain drive :
- e) Gear drive :
- f) Size of belt/chain/gear :
- g) Size of pulley/sprocket :
- h) Diameter of main shaft :
- j) Recommended speed of main drive, (m/s) :

A-5 Washing Drum/Chamber

- a) Type :
- b) Material :
- c) Constructional feature :
- d) Diameter :
- e) Width :
- f) Recommended speed :

- g) Number and type of bearings :
- h) Number and size of tumbler bars :
- j) Type of abrasive surface :
- k) Slope of drum, deg. (%) :

A-6 Water Supply System

- a) Type of water spray system :
- b) Length of pipe, m :
- c) Diameter of pipe, mm :
- d) Number of perforations/nozzles :
- e) Diameter of perforations/nozzles, mm :
- f) Spacing of perforations/nozzles, mm :
- g) Details of spray assembly :
- h) Details of pump assembly, if any :
- j) Operating pressure of the pump, kPa :

A-7 Feed Inlet And Outlet

- a) Height and location of feeding system, m :
- b) Recommended maximum feed rate, kg/h :
- c) Size of feeding chute, mm × mm × mm :
- d) Size of outlet, mm × mm × mm :

A-8 Transport

- a) Type :
- b) Number of wheels :
- c) Size of wheels :
- d) Wheel bearing :
- e) Type of towing arrangement :
- f) Length of idle roller :
- g) Length of running roller :
- h) Drive :
- j) Type of bearing :

A-9 Overall Dimensions

- a) Length, mm :
- b) Width, mm :
- c) Height, mm :
- d) Ground clearance, mm :
- e) Total mass (app.), kg :

A-10 Tools, Accessories and Manuals Provided

Test Engineer

(Clause 10.4.1.2)

DATA SHEET FOR MATERIAL OF CONSTRUCTION

B-1 Date of Test :

B-2 Material of Construction :

Sl. No.	Component	Material	Size (Wherever applicable)
i)	Bearing housing/plummer block		
ii)	Bottom and top drum of Elevator		
iii)	Elevator body/frame		
iv)	Tumbler bar		
v)	Abrasive Material		
vi)	Feed hopper/feeding system		
vii)	Water spray assembly		
viii)	Feed roll		
ix)	Feed rate/distribution plates		
x)	Outlet		
xi)	Main frame		
xii)	Pulleys/gears/sprockets		
xiii)	Shafts		
x)	Hand wheels/adjustment levers		
xi)	Shafts		

Test Engineer

ANNEX C
(Clause 10.4.1.3)

**DATA SHEET FOR VISUAL OBSERVATIONS AND PROVISION
FOR ADJUSTMENTS**

C-1 Observations:

- a) Adequacy of marking of inlet and outlets
- b) Adequacy of protection of bearings against the ingress of dust
- c) Adequacy of safety arrangements, especially at moving points and at inlet
- d) Provision for lubrication of moving parts
- e) Provision for belt tightening
- f) Provision for transportation
- g) Provision for easy changing of components requiring frequent replacement
- h) Provision for easy cleaning of perforations to remove clogging
- j) Provision for anti-corrosive coatings
- k) Tightness of bolts, nuts and other fasteners
- m) Welding of seams
- n) Adequacy of marking of direction and speed of shaftes/drives.

C-2 Provision for Adjustments of:

- a) Feed rate
- b) Shaking/rotating speed of washing chamber
- c) Washing drum speed
- d) Slope of washing drum
- e) Water spaying

Test Engineer

ANNEX D
(Clause 10.4.2.2)

DATA SHEET FOR TEST AT NO-LOAD

D-1 Power Consumption

- a) Source of power
- b) Type of drive
- c) Total time of run, min.
- d) Average energy/fuel consumption for one hour, W or litre

Test Engineer

ANNEX E
(Clause 10.4.3.1)

DATA SHEET FOR TEST AT LOAD

E-1 Source of Power

E-2 Power Rating

E-3 Type of Drive

E-4 Percentage of Soil/Mud on The Surface of The Vegetable Feed Before Feeding

E-5 Slope of Washing Chamber

E-6 Flow Rate of Water, m³/min.

E-7 Maximum Input Capacity, kg/h

E-8 Test Data*

Sl. No.	Date	Starting time	Stopping time	Duration of operation	Speed (m/s)	Feed rate (kg/h)	Power required (kW)	Fuel consumed (l/h)	No. of samples	Quantity (kg) of samples		Total quantity of washed vegetable received at outlet (kg)	Total quantity of grain mixture at sieve under flow (kg)
										At feed	At washed vegetables outlet		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
									i)				
									ii)				
									iii)				

E-9 Observations:

- a) Presence of any marked vibration during operation
- b) Presence of undue knocking or rattling sound
- c) Frequent slippage of belts / chain
- d) Smooth running of shafts in their respective bearings
- e) Frequent clogging of perforations in washing chamber
- f) Smooth flowing of material through different components
- g) Any marked rise in bearing temperature

- h) Any marked wear, deformation and breakdown in any components
- j) Frequent loosening of fasteners
- k) Other observations (if any)

Test Engineer

ANNEX F
(Clause 10.4.3.2)

DATA SHEET FOR ANALYSIS OF SAMPLES

Sl. No.	Feed rates	Sample No.	Weight of soil from 100 g of sample, g		Microbial load from vegetable sample, cfu/g		Weight of sample, kg		Retention time, min.
			Unwashed, W_{uw}	Washed, W_w	Unwashed, I_{ml}	Washed, F_{ml}	Bruised, W_{bs}	Total sample, W_{ts}	
		i.							
		ii.							
		iii.							
		Mean							

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ANNEX G
(Clauses 10.4.3.2)

**DATA SHEET FOR EFFICIENCY, POWER REQUIREMENT
AND CAPACITIES**

Sl. No.	Item	Test No.				
		1	2	3	4	5 etc.
1	Feed rate, t/h					
2	Power required, kW					
	Fuel required, l/h					
3	Speed of washing chamber, rev. min. (m/s)					
4	Total mass of vegetables received at outlet, ton					
5	Mechanical washing efficiency, %					
6	Microbial washing efficiency, %					
7	Percentage bruising, %					
8	Water requirement, litre/ tonne					
9	Retention time for vegetables, min.					
10	Rated input capacity, tonne / h					
11	Specific capacity, tonne /kW h					
12	Specific energy requirement, k Wh/tonne					

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ANNEX H
(Clause 11)

DATA SHEET FOR LONG-RUN TEST

H-1 Total Running Time

H-2 Continuous Running Time

H-3 Breakdowns in Washing Unit

H-4 Breakdowns in Water Supply System

H-5 Breakdown in Body/Frame

H-6 Any Major Repairs Conducted

H-7 Any Other Observations

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ANNEX J
(Clause 12)

SUMMARY REPORT

J-1 Name of Manufacturer

J-2 Model Number

J-3 Name of Testing Station

J-4 Brief Description of The Vegetable Washing Unit

J-5 Type and Variety of Vegetable Used

J-6 Percentage of Foreign Matter/Soil/Mud Present Before Washing, g/kg

J-7 Provisions for Adjustment:

- a) Speed of washing chamber
- b) Slope of washing chamber
- c) Water supply
- d) Feed rate

J-8 Power Requirement, kW:

- a) Recommended power
- b) Observed power at no-load
- c) Observed power at load at rated input capacity
- d) Observed power at maximum input capacity

J-9 Mechanical Washing Efficiency, %

J-10 Microbial Washing Efficiency, %

J-11 Percentage Bruising, %

J-12 Water Requirement, Litre/Tonne

J-13 Retention Time for Vegetables, min.

J-14 Rated Input Capacity, q/h

J-15 Specific Capacity, t/kW h

J-16 Specific Energy Requirement, k Wh/tonne

J-17 Any Marked Observation Affecting Performance

J-18 Any Marked Breakdowns

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