

PHILIPPINE NATIONAL STANDARD

**PNS/BAFS 331:2022
ICS 65.060.40**

Knapsack Sprayer – Specifications



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Foreword

In 2016, the Philippine Council for Agriculture and Fisheries (PCAF)-Agricultural and Fishery Mechanization Committee (AFMeC) issued Resolution No. 6, series of 2016 (Endorsing to the DA Secretary through the BAFS the Identified Agricultural Fisheries Machinery, Equipment and Infrastructures for Philippine Agricultural Engineering Standards [PAES]/ PNS Development and Updating) endorsing the revision of the PAES on Lever-Operated Knapsack Sprayer – Specifications (PAES 112:2000) and Methods of Test (PAES 113:2000). The purpose of the revision is to update the standards to reflect current technologies on knapsack sprayer and address procurement challenges.

In response, the Bureau of Agriculture and Fisheries Standards (BAFS) conducted a Focus Group Discussion (FGD) in 2018 to discuss the major issues on knapsack sprayer. A Technical Working Group (TWG) was then created to revise the PNS under Special Order (SO) No. 1092 series of 2018 (Creation of Technical Committees and its TWGs for the Development of PNS for Agriculture and Fisheries Products and Machinery, Tools, and Equipment). This was later amended and updated through SO No. 817 series of 2021 (Addendum to Special Order 81, Series of 2021 Entitled, “Creation of TWG for the Development of PNS for Agriculture and Fishery Products, Machinery, and Equipment”) and SO No. 103, series of 2022 (Creation of TWG for the Development of PNS for Agriculture and Fishery Products, Machineries, and Infrastructure). The TWG is composed of representatives from relevant DA agencies, other National Government Agencies (NGAs), academe, research institution, private sector, and Civil Society Organizations (CSOs).

TWG meetings were conducted for the period October 2019 to May 2020. The TWG agreed to delay the discussion of the PNS, taking into consideration the then revision of the major ISO reference documents in 2020, which are the ISO 19932-1:2013 (Equipment for crop protection — Knapsack sprayers — Part 1: Safety and environmental requirements) and ISO 19932-2:2013 (Equipment for crop protection — Knapsack sprayers — Part 2: Test methods). In September 2021, the drafting of the PNS resumed after the revision of ISO references was canceled. The draft PNS underwent a series of TWG meetings and stakeholder consultations conducted via blended platforms. In May 2022, the Philippine Council for Agriculture and Fisheries (PCAF) – Committee on Agricultural and Fisheries Mechanization (CAFMeCh) also recommended for the approval of the final draft PNS through the issuance of Resolution No. 35, series of 2022 (Recommending to the DA Secretary the Approval of the Final Drafts of the PNS for Knapsack Sprayer – Specifications and Methods of Test and the PNS on Technical Means for Ensuring Safety – Guidelines). The final draft PNS was subsequently endorsed to the DA Secretary for approval.

This BAFS/PNS edition includes the following significant changes relative to the previous PAES 112:2000:

- a) Modification of the scope to include 4 new classifications of knapsack sprayer (i.e., compression, engine-driven, electric motor-driven and dual knapsack sprayer);
- b) Modification of terms and definitions;
- c) Inclusion of typical illustration of every classification of knapsack sprayer;
- d) Adoption of applicable minimum requirements from ISO 19932-1:2013 (Equipment for crop protection — Knapsack sprayers — Part 1: Safety and environmental requirements);
- e) Modification of provisions under “Fabrication” and “Performance requirements”; and
- f) Inclusion of clause on the Specific Requirements of each classification of knapsack sprayer.

This Standard cancels and replaces PAES 112:2000 (Lever-operated knapsack sprayer —Specifications). This PNS was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2.

1 Scope

This Standard specifies the requirements for the construction and performance of knapsack sprayers. It covers lever-operated, compression, engine-driven, electric motor-driven, and dual knapsack sprayers intended primarily for agriculture production.

2 Normative Reference

The following documents are referred to in the text in such a way that some or all their contents constitute the requirement of this document. The latest edition of the referenced document (including any amendments) applies.

AMTEC - UPLB. (2000). Agricultural machinery — Method of sampling (PAES 103:2000). <https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2019/07/PAES-103-2000-Agricultural-Machinery-Method-of-Sampling.pdf>

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Bureau of Agriculture and Fisheries Standards (BAFS) - Department of Agriculture (DA). (2016). Agricultural and fisheries machinery — Guidelines on after-sales service (PNS/BAFS PAES 192:2016). http://www.bafs.da.gov.ph/bafs_admin/admin_page/pns_file/2021-02-26-PNS%20BAFS%20PAES%20192_2016-%20Guidelines%20on%20After-%20Sales%20Service.pdf

BAFS - DA. (2022). Knapsack sprayer — Methods of test (PNS/BAFS 332:2022).

3 Terms and Definitions

For the purpose of this Standard, the following terms and definitions shall apply:

3.1

filter

strainer

device which separates materials larger than a pre-determined size from the spray liquid (ISO, 2020, *modified*)

3.2

knapsack sprayer

self-contained sprayer carried on the operator's back or shoulder by means of straps or a strap (ISO, 2013, *modified*)

3.2.1

electric-motor driven knapsack sprayer

power-operated knapsack sprayer which uses an electric motor-powered pump to generate pressure to atomize and/or transport the spray (ISO, 2020, *modified*)

3.2.2

lever-operated knapsack sprayer

continuous manually-operated knapsack sprayer which uses a lever-operated pump to pressurize the spray liquid in the tank for application through hydraulic energy nozzle (ISO, 2020, *modified*)

3.2.3

knapsack compression sprayer

manually-operated knapsack sprayer which pressurizes the tank using air before spraying (ISO, 2020, *modified*)

3.2.4

engine-driven knapsack sprayer

power-operated knapsack sprayer which uses an engine-powered pump to generate pressure to atomize and/or transport the spray (ISO, 2020, *modified*)

3.2.5

dual knapsack sprayer

combination of a lever and electric-motor driven knapsack sprayer

3.3

nozzle

device used to form droplets from a spray liquid (ISO, 2020)

3.4**pressure chamber**

component of the sprayer that evens out the fluctuations of the fluid pressure and induces more uniform flow of the sprayed liquid (AMTEC-UPLB, 2000)

3.5**rated operating pressure**

operating pressure recommended by the manufacturer

3.6**spray tank**

reservoir or chamber which contains the spray liquid (ISO, 2020, *modified*)

3.7**tank nominal volume**

volume indicated by the maximum filling level marked on the spray tank, expressed in liters (L) (ISO, 2013, *modified*)

3.8**total volume**

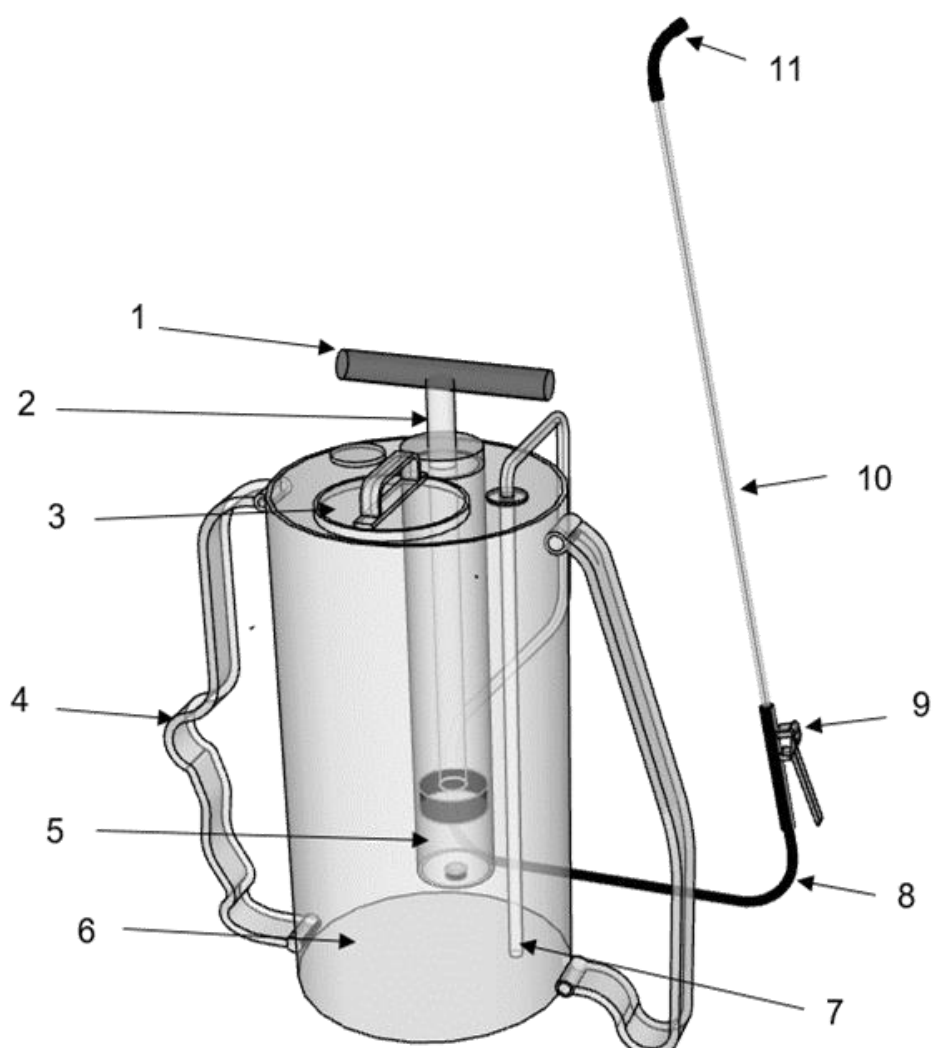
maximum allowable volume of the liquid to fill the spray tank, expressed in liters (L), also known as tank capacity or sprayer capacity (AMTEC-UPLB, 2000, *modified*)

4 Classifications

The classifications of knapsack sprayer shall be based but not limited to the following:

4.1 Manually-operated knapsack sprayer**4.1.1 Compression**

A knapsack sprayer that operates by means of one time compression per spray. The basic part of a compression type knapsack sprayer is shown in Figure 1.

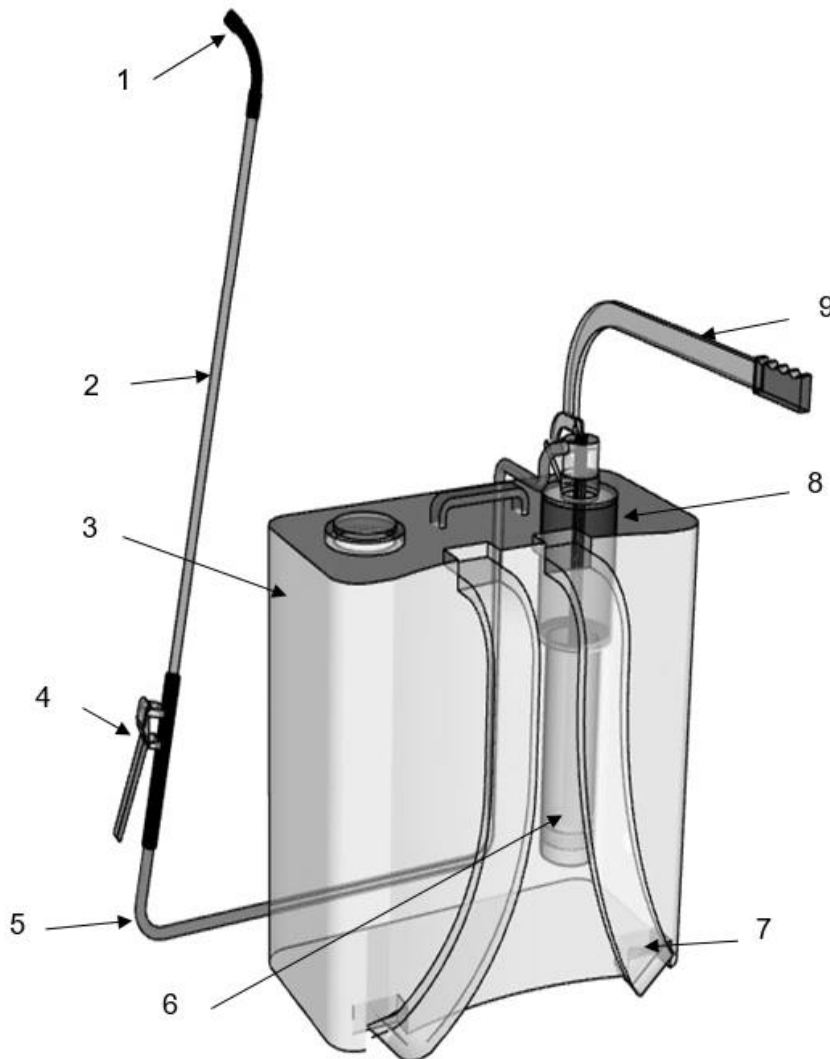
**Key:**

- 1 handle
- 2 plunger rod
- 3 tank cover
- 4 strap
- 5 pump assembly
- 6 spray tank
- 7 dip tube
- 8 hose
- 9 cut-off valve
- 10 lance
- 11 nozzle

Figure 1. Typical illustration of a knapsack compression sprayer (AMTEC - UPLB, 2022)

4.1.2 Lever-operated or continuous

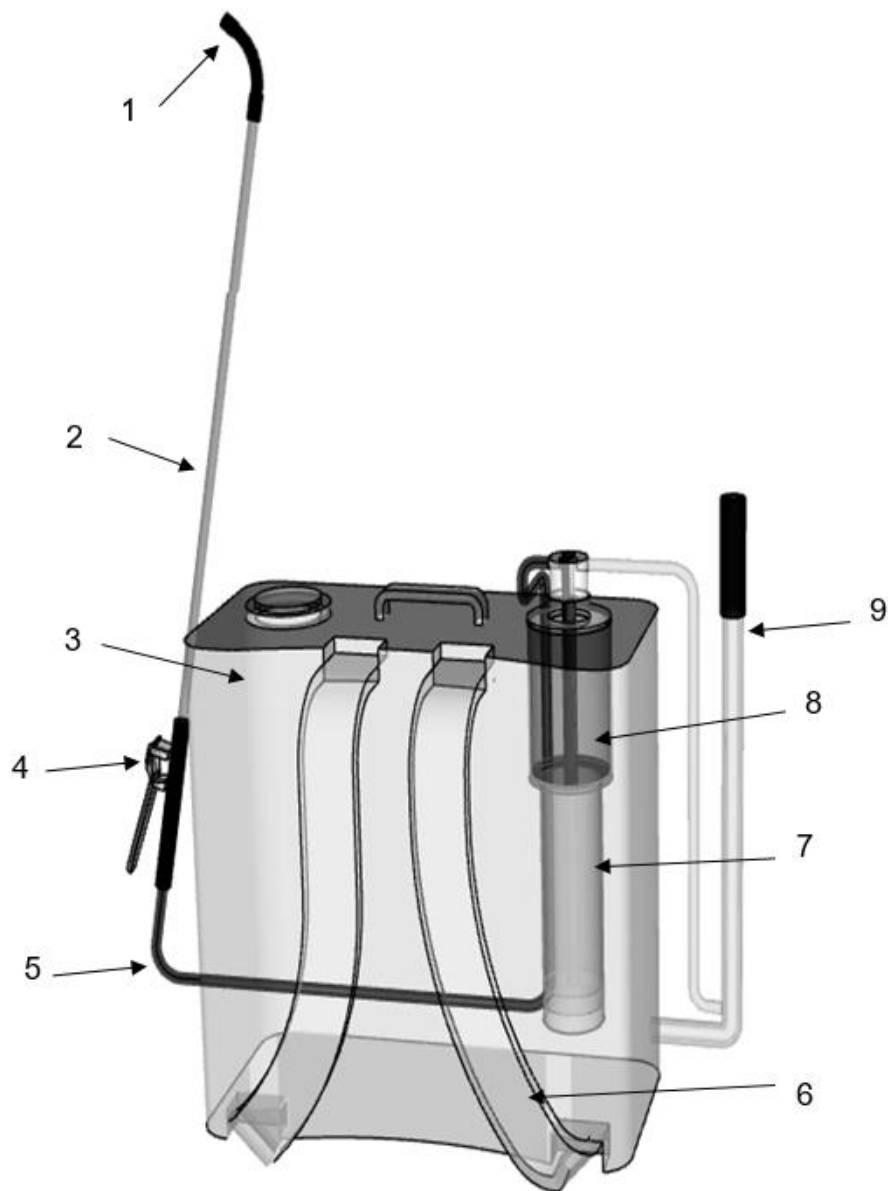
A knapsack sprayer that operates by means of continuous compression when spraying. Typical lever-operated or continuous type of knapsack sprayers (over-the-shoulder and under-the-arm) are illustrated in Figure 2.



Key:

- 1 nozzle
- 2 lance
- 3 spray tank
- 4 cut-off valve
- 5 hose
- 6 pump assembly
- 7 strap
- 8 pressure chamber
- 9 lever

a) over-the-shoulder



- Key:**
1 nozzle
2 lance
3 spray tank
4 cut-off valve
5 hose
6 strap
7 pump assembly
8 pressure chamber
9 lever

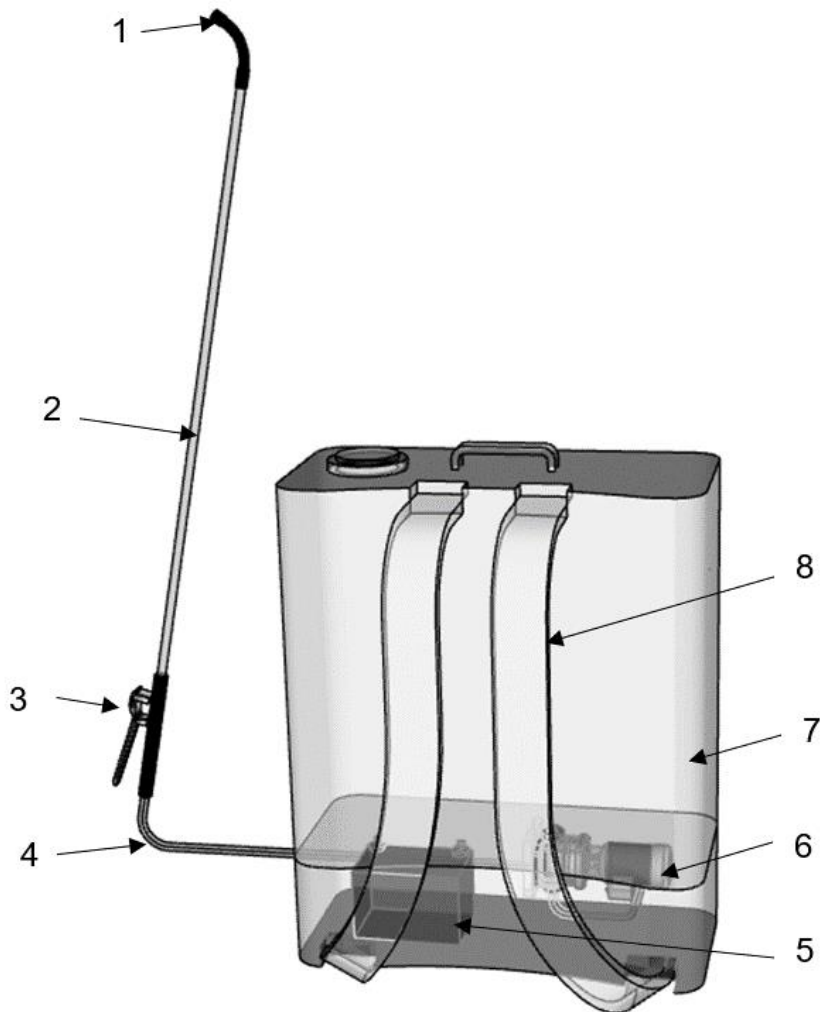
b) under-the-arm

Figure 2. Typical illustration of an a) over-the-shoulder and b) under-the-arm lever type knapsack sprayer (adapted from AMTEC - UPLB, 2022)

4.2 Power-operated knapsack sprayer

4.2.1 Electric motor-driven

A knapsack sprayer that operates by means of pressurization of the spray liquid through an electric-powered pump. A typical electric motor-powered pump operated knapsack sprayer is shown in Figure 3.



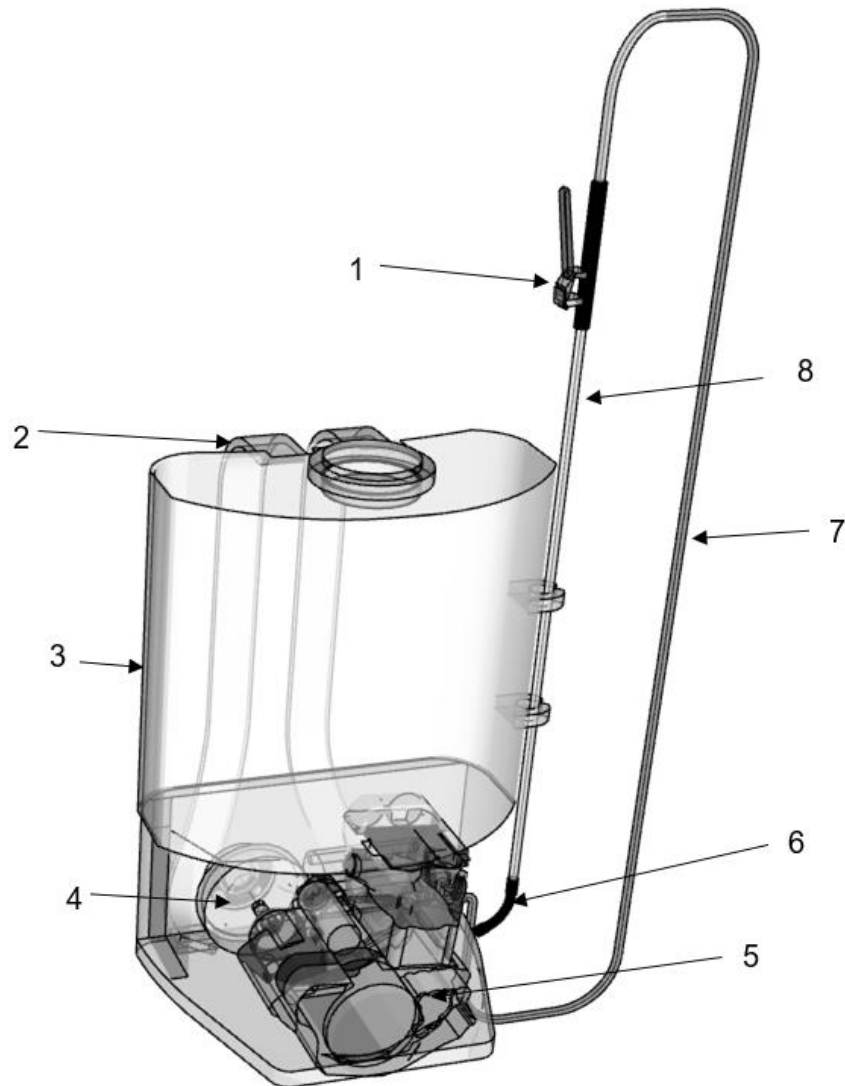
Key:

- 1 nozzle
- 2 lance
- 3 cut-off valve
- 4 hose
- 5 battery
- 6 electric motor-powered pump
- 7 spray tank
- 8 strap

Figure 3. Typical illustration of a electric motor-driven knapsack sprayer (adapted from AMTEC, 2022)

4.2.2 Engine-driven

Knapsack sprayer that operates by means of pressurization of the spray liquid through an engine-powered pump. A typical engine-driven knapsack sprayer is shown in Figure 4.



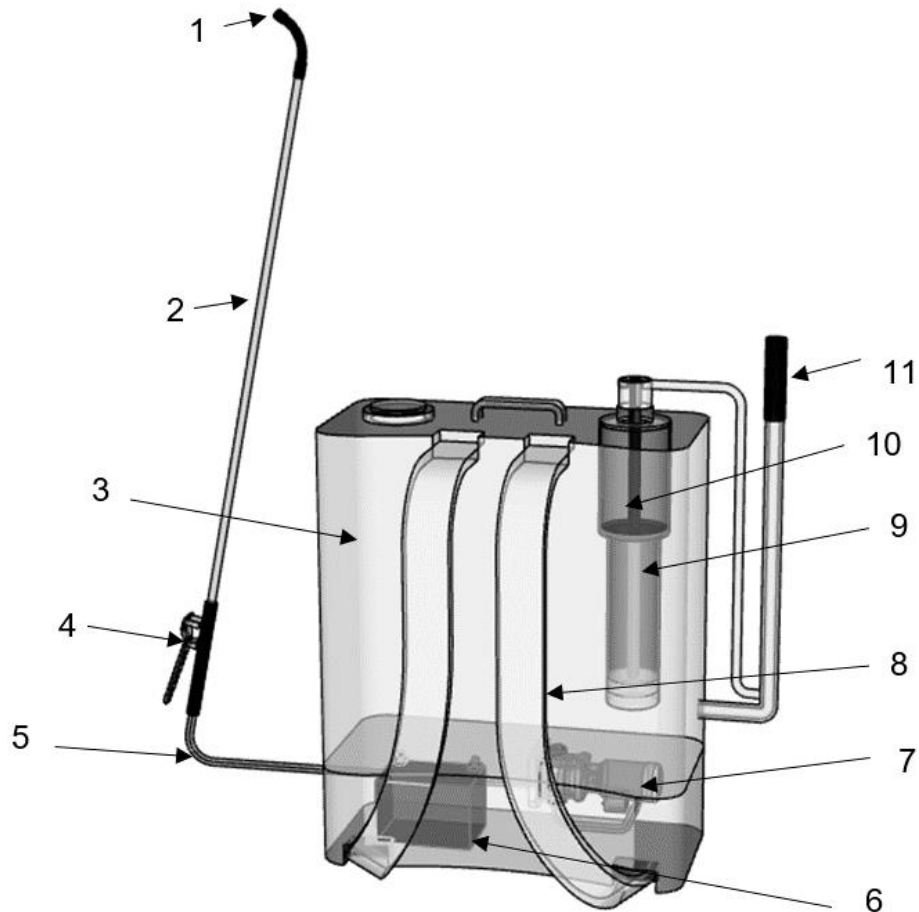
Key:

- 1 cut-off valve
- 2 strap
- 3 spray tank
- 4 pump
- 5 engine
- 6 nozzle
- 7 hose
- 8 lance

Figure 4. Typical Illustration of an engine-driven knapsack sprayer (adapted from AMTEC - UPLB, 2022)

4.3 Dual

Knapsack sprayer that operates by means of either continuous manual pumping or electric motor-powered pump pressurization. An example of a dual knapsack sprayer is shown in Figure 5.



Key:

- 1 nozzle
- 2 lance
- 3 spray tank
- 4 cut-off valve
- 5 hose
- 6 battery
- 7 electric motor-powered pump
- 8 strap
- 9 pump assembly
- 10 pressure chamber
- 11 lever

Figure 5. Typical illustration of a dual knapsack sprayer (adapted from AMTEC, 2022)

5 Fabrication requirements

5.1 General

5.1.1 All permanent joints shall not show any sign of failure, when tested for durability, as specified in the PNS/BAFS 332:2022 (Knapsack sprayers – Methods of test).

5.1.2 Pressurized parts of the sprayer shall withstand twice the rated operating pressure.

5.2 Spray tank

5.2.1 For engine-driven knapsack sprayer, the tank nominal volume should not be more than 40 kg. For other sprayers (i.e., lever-operated, compression, electric motor-driven, and dual), the tank nominal volume shall not be more than 25 kg.

5.2.2 For compression knapsack sprayer, the spray tank volume shall exceed the nominal volume by at least 25%. For other sprayers (i.e., lever-operated, engine-driven, electric motor-driven, and dual), the spray tank volume shall exceed the nominal volume by at least 5%.

5.2.3 The sprayer shall remain upright and stable when placed on a level surface. It shall be easy for the user to lift the sprayer at full tank and its components onto the back.

5.2.4 The spray tank shall have a minimum capacity of 10 L.

5.2.5 The nominal volume shall be specified in whole liter (L).

5.3 Filter assembly

5.3.1 The sprayer shall contain a minimum of two filters, which are made of corrosion resistant material that allows for easy cleaning, maintenance, and/or replacement.

5.3.2 The design of the spray tank inlet strainer shall be such that it allows rapid filling of the tank without splashing. The spray tank inlet strainer shall have at least 16 holes per square centimeter (mesh 16/cm²).

5.4 Spray tank inlet

5.4.1 The sprayer shall be filled through the spray tank inlet without spillage.

5.4.2 The lid shall allow easy and secure fitting by the gloved hand of an operator and shall provide an effective seal. There should be a provision for chain, string or any form of attachment of the lid to the sprayer tank to avoid misplacement of the lid.

5.4.3 Any air vent in the lid or tank shall limit the escape of spray liquid to 5 mL if the sprayer is completely inverted for five minutes.

5.5 Hose and lance

5.5.1 The hose should be made of either rubber or synthetic material. If made of rubber, it shall have one or more plies of fiber reinforcement.

5.5.2 Hoses shall be retained on connectors and couplings preferably by clamps or clips of the worm drive type. Threaded connections may be of any design provided that the strength and size permit liquid tight joints to be made by thumb pressure at the highest operating pressure of the sprayer.

5.5.3 To allow free handling of the spray lance, the length of the hose from the hose nipple of the spray tank to that of the spray lance hand grip shall be at least 1200 mm.

5.5.4 The spray lance shall provide a sufficient distance from the operator to the spray. The length of the lance shall be at least 500 mm.

5.6 Cut-off valve assembly

5.6.1 The cut-off valve shall have a lock-on and lock-off feature.

5.6.2 The cut-off valve shall not leak or break when subjected to leak test.

5.7 Nozzle assembly

5.7.1 At least two nozzles that can deliver two different spray qualities (e.g., fine, medium or coarse) depending on the intended use, as characterized in Table 2 (Droplet size classification), shall be provided.

Table 2. Droplet size classification¹

VMD, μm	Spray Quality	Use
<60	Extremely Fine	-
61-105	Very Fine	-
106-235	Fine	Good Cover
236-340	Medium	Most Products
341-403	Coarse	Systemic Herbicides
404-502	Very Coarse	Soil Herbicides
503-665	Extremely Coarse	Liquid Fertilizer
>665	Ultra Coarse	Liquid Fertilizer

¹ American Society of Agricultural and Biological Engineers (ASABE). (2020). Droplet size classification (ASABE S-572.1).

5.7.2 The nozzle body should contain a filter, which can be cleaned, maintained, or replaced. It shall be provided with a standard thread to fit the lance.

5.8 Strap

- 5.8.1 Adjustable strap/s shall be provided to carry the sprayer.
- 5.8.2 All materials used for the strap shall be durable.
- 5.8.3 The length of strap shall be minimum of 425 mm.
- 5.8.4 The sprayer strap, straphangers or strap clip shall not fail or get damaged during operation when subjected to strap test.
- 5.8.5 A quick-release mechanism shall be provided for emergency purposes.
- 5.8.6 The increase in mass of straps after defined immersion in water shall not exceed 30% of the dry mass.

5.9 Connectors and fasteners

- 5.9.1 All hose-connections shall have the same diameter. They shall be interchangeable and provided with reusable clamps.
- 5.9.2 All other external connectors shall be of standard thread size. They shall be designed to avoid a potential source of leakage.
- 5.9.3 Fasteners shall not penetrate the pressure chamber.

5.10 Pressure gauge

- 5.10.1 A pressure gauge, if provided, shall have an accuracy of $\pm 1\%$ of the full scale.
- 5.10.2 The gauge shall be in a position where it is clearly visible when spraying and shall be installed before the cut-off valve.

5.11 Fluid level

A fluid level indicator, if provided, should be clearly marked and visible, at 1-liter graduation with maximum error of $\pm 10\%$.

6 Performance Requirements

- 6.1 The sprayer should have a minimum volumetric efficiency of 80%.
- 6.2 The sprayer shall not leak from the body or any of its component parts and the pressure shall not drop by more than 50% of the applied pressure when subjected to leak test.
- 6.3 The sprayer shall not have any abnormality or trouble when subjected to continuous running test.

6.4 The flow rate from the sprayer using water and the nozzles provided, shall range between 0.3 to 1.4 L/min at the rated operating pressure.

6.5 The sprayer shall attain a medium spray quality as shown in Table 2, unless otherwise specified by the manufacturer.

7 Specific Requirements

7.1 Lever-operated knapsack sprayer

7.1.1 General

7.1.1.1 The sprayer shall remain functional after a defined drop.

7.1.1.2 After the pressure test is conducted and after a duration of 30 s, as defined by PNS/BAFS 332:2022, the total volume of leakage shall:

- a) Have no leak when in upright position;
- b) Not exceed 0.5 mL when in 45° position; and
- c) Not exceed 5 mL when in horizontal position.

7.1.1.3 The lever should be accessible to enable right- or left-hand operation. Its length and position shall be such that it is comfortable to operate.

7.1.1.4 Knapsack sprayer shall have a well-engineered design of high-quality construction and components which are readily accessible, serviceable, and considered durable over the expected life of the sprayer.

7.1.1.5 Vertical movement at the end of the lever shall not exceed 400 mm.

7.1.1.6 The grip should be comfortable to hold and securely fastened to the lever. It should have a minimum diameter of 25 mm and a minimum length of 100 mm.

7.1.2 Straps

The load bearing part of the strap shall be at least 50 mm wide and shall have a length of at least 200 mm and a thickness of at least 4 mm.

7.2 Knapsack compression sprayer

7.2.1 General

7.2.1.1 The sprayer shall not suffer any performance deterioration after the specified drop test.

7.2.1.2 The sprayer shall not leak in any position.

7.2.2 Strap

7.2.2.1 A double shoulder strap shall be provided for all sprayers exceeding a weight of 15 kg. Sprayers having a weight of 15 kg or less shall be provided with at least a single shoulder strap.

7.2.2.2 The load bearing part of the strap shall be at least 50 mm wide and shall have a length of at least 200 mm and a thickness of at least 4 mm.

7.2.3 Spray tank

7.2.3.1 Sprayers should have an inlet opening of at least 100 mm diameter. If the diameter is less than 100 mm, a separate funnel of at least 100 mm diameter shall be provided.

7.2.3.2 The spray tank shall be equipped with a pressure-relief device that prevents pressurization of the spray tank beyond the maximum working pressure prescribed by the manufacturer plus 20%. The device shall reseal automatically to allow normal operation of the sprayer without leakage.

7.3 Engine-driven knapsack sprayer

7.3.1 General

7.3.1.1 After the pressure test is conducted and after a duration of 30 s, as defined by PNS/BAFS 332:2022, the total volume of leakage shall:

- a) Have no leak when in upright position;
- b) Not exceed 0.5 mL when in 45° position; and
- c) Not exceed 5 mL when in horizontal position.

7.3.2 Spray tank

7.3.2.1 The amount of liquid remaining in the tank shall not exceed 50 mL after operation.

7.3.2.3 Engine starting device shall be provided to allow starting of the engine without the need for separate and independent auxiliary assistance (e.g., belts or cables). If the engine is fitted with an electric starting device, two or more independent and dissimilar motions shall be required to engage the device. The sprayer shall be fitted with an engine-stopping device through which the engine can be brought to a full stop and that does not depend on sustained manual effort for its operation.

7.3.3 Straps

The load bearing part of the strap shall be at least 65 mm wide and shall have a length of at least 200 mm and a thickness of at least 10 mm.

7.3.4 Fuel tank

7.3.4.1 Fuel inlet shall have a strainer. Fuel tanks shall have an air vent.

7.3.4.2 Fuel-tank openings shall be at least 20 mm in diameter and the oil-tank opening (if any) shall be at least 15 mm in diameter.

7.3.4.3 The design of the fuel-tank assembly shall be such that no leakage occurs in any operating and transport position at normal operating temperature.

7.3.5 Pressure regulation

7.3.5.1 Pressure control (e.g., relief valve) shall prevent excessive pressure build up on the sprayer and its components.

7.3.5.2 It should be positioned external to the tank. If positioned internally, there shall be means of adjustment from the outside of the tank.

7.3.6 Hot parts

Insulation and protection devices shall be provided to minimize the possibility of inadvertent contact with any exposed element which may cause burns during mounting, dismounting or operating the machinery. Legible and non-removable warning notices or signs made of heat resistant materials for hot parts shall be provided.

7.3.7 Exhaust system

Exhaust outlets shall be located to direct exhaust emissions away from the operator in the normal operating position.

7.3.8 Parts under high voltage

All parts of the engine which are under high voltage shall be insulated to avoid hazards or accidents.

7.3.9 Noise

There shall be a provision of earmuffs or other ear protection device for the operator to use when 92 dB(A) is exceeded during operation.

7.3.10 Vibration

Vibration reduction shall be an integral part of the design process, specifically taking into account measures at source. Technical measures such as isolators and resonating masses shall be used to isolate the vibration from the handle, when appropriate.

NOTE The success of the applied vibration reduction measures is assessed based on the actual vibration total values for each handle. The main

sources causing and influencing vibration are generally the dynamic forces from engine, unbalanced moving parts, clutch, bearings, pumps and other mechanisms and the interaction between operator and the sprayer.

7.4 Electric motor-driven knapsack sprayer

7.4.1 The provision for the electric motor-driven knapsack sprayer shall conform to 7.3 except for, 7.3.4, 7.3.5, and 7.3.7.

7.4.2 For strap, the load bearing part of the strap shall be at least 50 mm wide and shall have a length of at least 200 mm and a thickness of at least 4 mm.

7.4.3 The sprayer shall be able to continuously operate at rated operating pressure for at least two hours.

7.5 Dual knapsack sprayer

The provision for specific requirements for electric motor-driven and lever-operated knapsack sprayer applies.

8 Safety, Workmanship, and Finish

8.1 The sprayer shall include among others at least one set of protective nose and mouth mask and a pair of eye goggles to protect the operator against inhalation and eye irritation, respectively due to spray chemicals.

8.2 The sprayer shall conform to the operator's body, shall have a weight distributed evenly and shall have operating controls in reasonable locations and configuration.

8.3 No part of the outer surface shall entrap spilled liquid and there shall be no sharp edges or protrusions.

8.4 All valve parts shall be readily accessible for servicing and replacement.

8.5 There should be a convenient clip or any holder for the lance when not in use.

8.6 The cut-off valve shall be easy to use and comfortable to operate.

8.7 The cut-off valve's handle grip shall be comfortable to hold and easy to use.

8.8 Engine or electric motor-driven sprayers shall be constructed in such a manner that access to power-driven components such as pulleys, shafts, gears and flywheels, and to drive belts and chains is prevented. For openings (e.g., covers and guards) the safety distances shall be in accordance with PAES 101:2000 (Agricultural machinery — Technical means for ensuring safety — General).

9 Warranty for Fabrication and Services

Warranty shall be provided for parts and services except for wearable parts for at least one year upon the acceptance of procuring entity of the knapsack sprayer. General requirements of the warranty shall conform to PNS/BAFS/PAES 192:2016 (Guidelines on after-sales service).

10 Maintenance and Operation

- 10.1** Each unit of knapsack sprayer shall be provided with a set of standard tools prescribed by the manufacturer.
- 10.2** An operator's manual which conform to PAES 102:2000 (Operator's manual — Content and presentation) shall be provided.
- 10.3** The knapsack sprayer shall be easy to clean and operate.
- 10.4** The pump, including its components and parts, shall be easily serviceable from the sprayer without the use of specialized tools, unless these are provided with or are part of the sprayer.
- 10.5** The spray tank inlet strainer shall be such that it can be easily removed by users for cleaning.
- 10.6** The cut-off valve assembly should contain an adequate filter, which can be cleaned, maintained, or replaced.

11 Sampling

Knapsack sprayers shall be sampled for testing in accordance with PAES 103:2000 (Methods of sampling) or any other suitable method of selection.

12 Testing

The sampled knapsack sprayers shall be tested in accordance with PNS/BAFS 332:2022 (Knapsack sprayer — Methods of test).

13 Marking and Labeling

- 13.1** Each unit of knapsack sprayer shall be engraved or embossed either in the body of the implement or in a metal nameplate attached at the most conspicuous place with the following information:

- a) Brand;
- b) Model; and
- c) Serial number.

- 13.2** Basic safety/precautionary markings shall be provided to the operator.
- 13.3** Basic operation reminder shall be stated in the operator's manual.
- 13.4** For sprayer with noise level expected to exceed 92 dB(A), a legible warning sign or notice shall be provided.

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