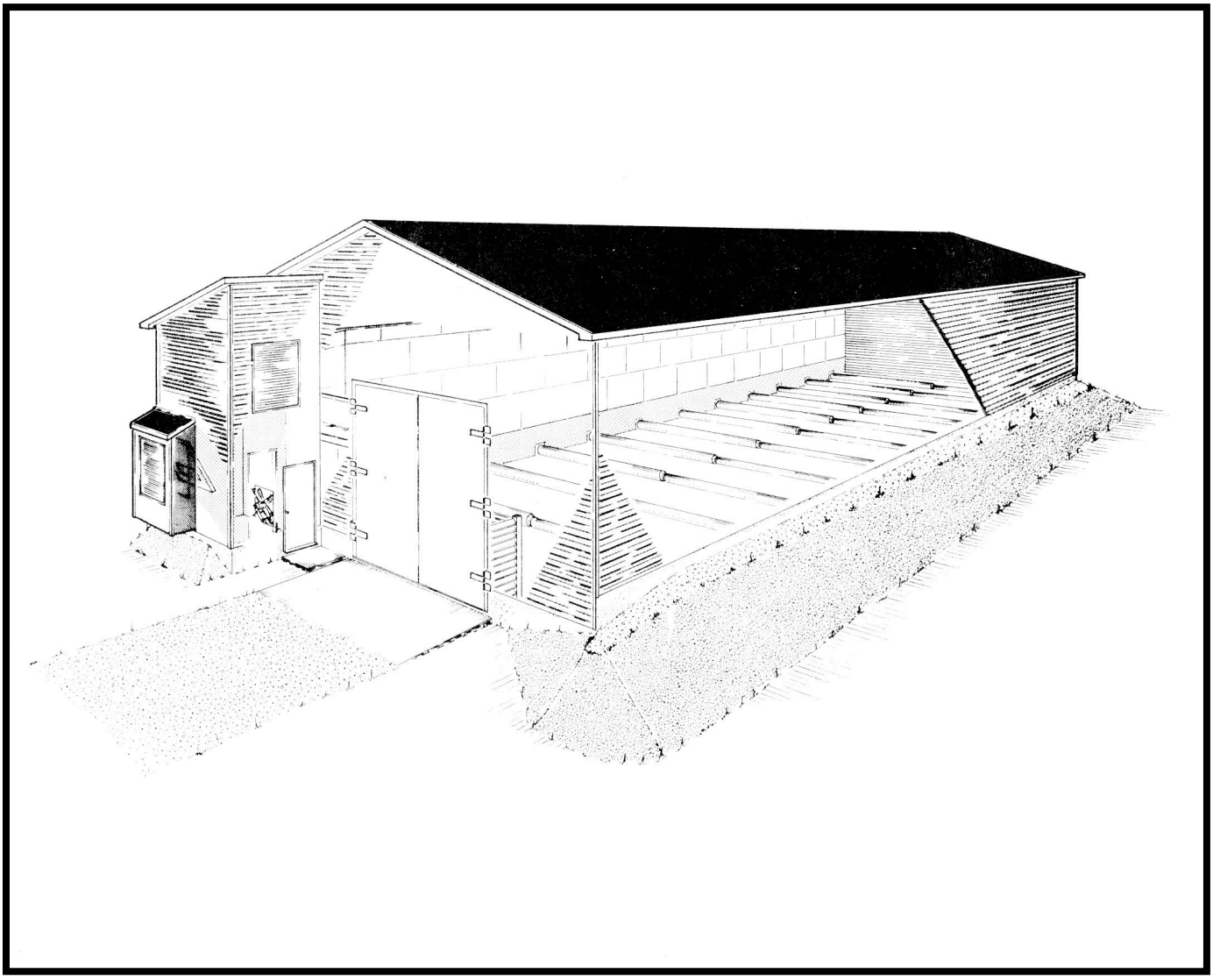
BRITISH COLUMBIA Ministry of Agriculture, Food and Fisheries
Agricultural Building Systems Handbook
PLAN
331-05

BULK POTATO STORAGE WITH SIDE AIR PLENUM



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BULK POTATO STORAGE WITH SIDE AIR PLENUM

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GENERAL FEATURES This bulk storage, 12 x 36 m (40 x 120 ft) is designed to hold about 1100 tonne of potatoes, at a depth of 4.5 m (15 ft). The same basic structure can also be used for bulk storage of other vegetables such as turnips and carrots, holding smaller amounts at less depth than usual for potatoes.

The building is of well-insulated wood frame construction. It has large insulated storage doors at one end. A modern ventilation system, with a fan house and control room, forces air down a side plenum and through the pile of produce by way of lateral ducts laid on the floor.

This building is insulated with fiberglass and sealed with vapor barrier near the inside. **It is not suited for long-term refrigerated storage**. For refrigerated storage modify the wall and ceiling system, using a rigid foam insulation as shown in plan **330-11**. Other structural details need not be changed.

PLAN DETAIL AND OPTIONS The side air plenum with branch ducts provides good air flow control. The plenum also serves as a convenient walkway for checking the stored crop. Lateral air ducts laid on top of the floor at 2.4 m spacing are most common; alternatively they may be cast in the floor. Duct size and spacing can be adjusted for different ventilation rates. With access doors at both ends, this building could be cross-partitioned to store two varieties or batches of produce.

STRUCTURAL DETAIL All important structural details are shown on the plan. The walls are heavy stud frame construction to withstand the pressures of deeply piled potatoes. The foundation is designed with an offset footing and extra reinforcing steel to hold the large outward wall pressure without tipping. By finishing the outside grade well above the floor, the footings are protected from frost heave, and additional potato storage space is provided below grade.

It is important to insulate the foundation to reduce condensation and prevent chilling of crop near the foundation. This insulation is most effective applied to the outside. Use moisture-resistant extruded polystyrene foam board. It must be covered on the outside to protect against damage and sunlight. The best construction technique is to tack the rigid insulation to the inside face of the outside forms where it will bond to the fresh concrete when the foundation is cast. Finishing nails are best for this, as the small nail heads will simply pull out through the insulation board when the concrete forms are stripped.

Bulk produce exerts too great a pressure on the walls for ordinary anchor bolts. A specially designed wall anchor made from steel angle is shown. This must be welded ahead of time and ready to place in fresh concrete, so be prepared before ordering foundation concrete.

Exterior walls and ceilings must be well insulated to maintain the recommended high humidity (90% +). As a guideline the following insulation levels, in RSI units, are recommended:

Outdoor design temperature (^{o}C)	Insulation (RSI) Walls	Ceiling
-40	6.0	7.0
-30	5.0	5.5
-20	4.0	4.5
-10	3.0	4.5

Consult leaflet **306-53** for more details on insulation for vegetable storages.

When insulating walls and ceiling with bat insulation, it is important that the batts fit snugly into the stud space, flat against the inside surface. Be sure there are no bulges or gaps that will let cold air circulate along the inside wall surface. Also, do not overlook the need for a vapor-breathing windstop material under the exterior steel siding; asphalt felt is the usual material used here.

A well-sealed polyethylene vapor barrier is required on the inside of the wall and ceiling insulation. As added protection against possible decay in the walls, it is suggested to use pressure-treated wood sills and treat studs by dip-soaking their bottom ends in a safe, odorless wood preservative (for example copper napthanate, not penta (PCP) or creosote).

The air plenum wall, located in the high humidity storage environment on one side and wetted by the humidifier on the inside, is particularly subject to wood decay. For greatest durability here, use wood studs pressure-treated with ACA or CCA preservative. Otherwise use Douglas-fir studs; they are more decay resistant than spruce and hemlock. Dip treat their butt ends. The treated studs are kept from direct contact with vegetables by plywood or steel sheathing.

This plan suggests a stud wall height of 4.8 m (16 ft), for a total inside clear height of about 5.8 m (19 ft). A stud selection table on the plan allows design for other wall heights. To maximize the insulation effectiveness, select deeper studs at a wider spacings where the table offers a choice.

Ventilation is improved and pile temperature kept more uniform by lining the exterior walls with boards (cedar

preferred) spaced 40 mm out from the wall by vertical nailer strips.

Roof trusses must handle roof snow and dead load, **in addition to the outward pressure of the potato pile** on the walls. Be sure to increase the truss lower chords and connections to handle this extra force as specified on the plan. A special folded steel strap anchor is used to attach each truss to the side wall plate.

The ceiling is an important structural component in a bulk storage. It ties the end walls to the building, holding the high wall pressure. The ceiling also braces an empty building to resist wind forces. Following the ceiling construction details in the plan carefully.

Ceilings for vegetable storage may be either galvanized steel (plan **305-14**) or plywood. The steel ceiling lasts longer, but its shinier, less absorbent surface is slightly more subject to condensation than plywood. On the plywood ceiling, a dark-colored stain or paint provides better control of condensation and improves durability.

The air plenum and concrete floor are designed as a complete drainage system, for hosing out and disinfecting the storage. The concrete floor bears on top of the footings opposite the air plenum,and slopes slightly towards it. The plenum floor is a little below the storage floor so washwater can drain through the air duct openings. In the plenum, install a sump that can be drained or pumped for disposal.

In addition to storage cleaning, high capacity humidification often produces excess moisture which drains out of the air plenum. It helps to have the far end of the building about 100 mm higher than the fan end, but this requires more precise work in setting forms and footings to make the building “off-level”. Slope the floor, foundation and ceiling uniformly towards the fan end, but keep all the studs and endwalls vertical. Side-wall claddings will show a little ‘off-square’ when fastening in place, but this will disappear when trim and flashings are added.

VENTILATION The modern, fully automatic ventilation system controls temperature and circulates air through the potato pile. Air is forced along the main air plenum, outwards through the lateral ducts and up through the pile. It is a good idea to have a bypass valve through the floor at the end of the main plenum to provide partial recirculation of air to help control condensation in coldest weather.

The ventilation system for this storage is designed to provide 8 L/s per tonne (15 cfm/ton). Some storage situations may require greater airflow (for example, processing potatoes, and wet muddy harvest conditions). For increased ventilation adjust fan size, controls and duct design as required. Other storage applications, such as for seed potatoes and some other vegetables, may require less air than specified here.

Temperature of ventilating air is controlled by two sets of proportioning dampers which blend cold outside air with return air from inside the storage. Commercial control systems are available for this application. It is important to understand the operation of the particular system chosen.

These systems usually consist of the following components:

(1) Ventilating fan, to circulate the correct amount of air. Select fans to operate at a static pressure of 250-300 Pa (1.0 to 1.25 in., water gauge).

(2) Motorized dampers on fresh air and return air, usually controlled by separate damper motors.

(3) Air plenum thermostat, a modulating type that controls the damper motors to provide the precise temperature desired.

(4) Low-limit “safety” thermostat in the air plenum, to shut down the ventilation system if air temperature is too low for any reason.

(5) A differential thermostat that does not allow the system to operate when outside air is not cool enough to provide cooling. This control can also start and operate the ventilation system when outside air is cool enough (during the night, for example).

(6) A 24-hour clock for regulating operating time.

(7) A high capacity humidification system. Humidifier capacity should be about 30-40 L/(h.1000 tonne) or 7.5 gal/(h.1000 ton) of potatoes.

This plan shows the fan house, with fan and air blending controls, on the end of the storage to provide most efficient storage space. Alternatively this part of the structure could be inside the storage.

At the fan room, ventilation controls that use motorized dampers to blend ventilating air often have problems with freezing of the fresh air dampers in cold weather. This plan illustrates an effective method of minimizing this problem. Cold-air dampers are separated from the humid inside air by an insulated door which can be closed for cold weather. A smaller opening in this door, covered with a blanket or plywood, swings open for temperature control. This added feature is not required for locations where winter temperature is seldom colder than –20^{o}C.