LINESIG

LNS-VRU-WET

Vapour Recovery Unit

Data Sheet



Advantages

- Recovers valuable hydrocarbon vapours
- Reduces VOC emissions
- Improves terminal safety
- Supports environmental compliance
- Minimizes product loss

VACUUM-REGENERATED VAPOUR RECOVERY UNIT

MODEL : LNS-VRU-WET

1. PROCESS OVERVIEW

During tanker loading, incoming liquid displaces vapour and air from the tanker compartment. Without a controlled vapour-return arrangement, this displaced mixture can escape through the loading connection or vent path. The LINESIG LNS-VRU-WET is designed to collect that stream at the gantry and route it through a defined treatment and hydrocarbon-recovery process.

The reference process combines activated-carbon adsorption, vacuum regeneration and a downstream recovery stage. During adsorption, the hydrocarbons-bearing stream passes through an available carbon bed and hydrocarbons are retained on the carbon surface. A separate bed can be isolated and regenerated under vacuum, releasing a concentrated hydrocarbon stream for recovery. The beds alternate according to the selected operating sequence.

The package brings together adsorber vessels, switching valves, vacuum equipment, separation and recovery components, instrumentation, controls and the required terminal interfaces. The package arrangement is selected around vapour composition, loading profile, product-return destination, site conditions and the performance basis agreed for each application.

2. INDUSTRIAL APPLICATIONS & BENEFITS.

The LNS-VRU-WET product family is intended for hydrocarbon-vapour collection and treatment associated with loading and transfer. Its suitability depends on the product vapour characteristics, displaced-gas flow, loading arrangement and the recovery route available at the facility.

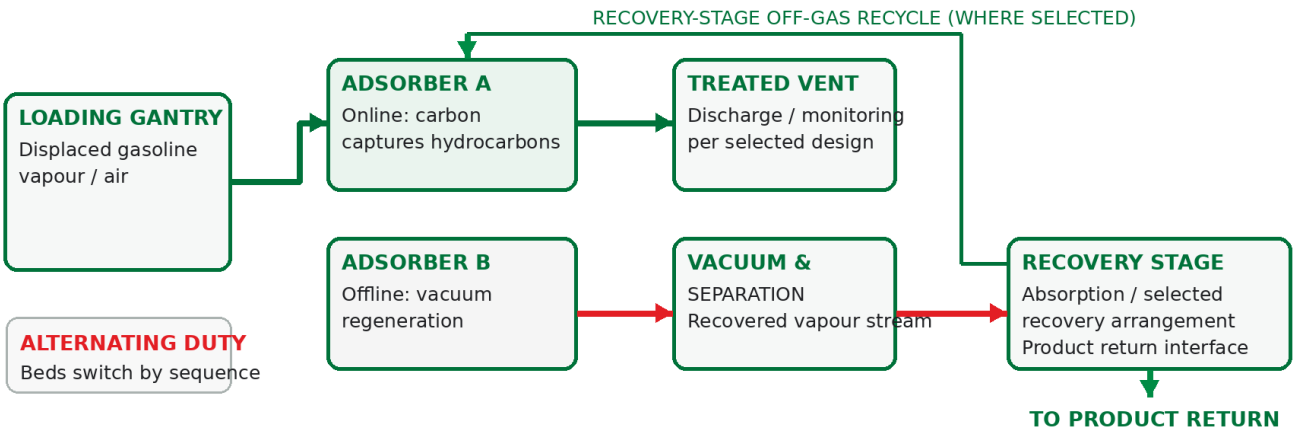
- **Oil and Gas Production Sites**:
  Captures low-pressure flash gas from crude oil production, casinghead gas, and storage tank breathing losses before they can be vented or flared.
- **Tank Farms and Terminals**:
  Manages vapours displaced during the filling and breathing of large petroleum and chemical storage tanks.
- **Truck and Rail Loading Racks**:
  Collects displaced vapours through loading arms when liquid fuel or chemicals are transferred into transport trailers
- **Marine Loading Jetties**:
  Recovers massive volumes of hydrocarbon or chemical vapours displaced during the loading and unloading of ships and barges
- **Chemical and Petrochemical Plants**:
  Captures volatile solvents, process vents, and drum-filling emissions to maintain product purity and curb hazardous air pollutants.
- **Pipeline Operations**:
  Handles emissions from pipeline pigging operations, compressor seal vents, and blowdown vents.

Core Benefits

- **Environmental Compliance**: Eliminates 95% or more of harmful VOC and methane emissions to meet strict regulatory standards like US EPA mandates.
- **Product Recovery & Revenue**: Recovers high-BTU gas or liquid hydrocarbons that can be sold or reused directly inside the plant process.
- **Safety Enhancement**: Lowers tank back-pressure, reduces fire or explosion risks, and suppresses foul odours around industrial sites.

3. PROCESS SCHEMATIC AND OPERATING PRINCIPLE.

The schematic shows a representative carbon-adsorption arrangement for gasoline loading. A loading-header stream is routed to the online adsorber. The second bed is isolated for regeneration, and the recovered hydrocarbon stream passes through a separation and recovery stage. Residual off gas may be returned to the active bed where the selected process design includes this recycle.



The Mechanism:
The system utilizes two or more alternating fixed beds packed with **activated carbon (AC)**. As the hydrocarbon-laden vapour flows through a bed, the active carbon acts like a microscopic sponge, physically binding the volatile organic compound (VOC) molecules to its surface while allowing clean air to vent safely into the atmosphere.

Regeneration Cycle:
While one bed is adsorbing, the other bed regenerates. A dry screw vacuum pump lowers the bed pressure significantly (down to 50–100 mbar) to strip the captured hydrocarbons off the carbon. These concentrated vapours are then sent to an absorber column, where a counter-flow of liquid product (e.g., gasoline) absorbs them back into a liquid state

Piping Arrangement.
The arrangement is a process concept for product communication. The final piping, bed count, recycle path, vent route, protective devices and recovery destination are developed from the approved process and terminal design basis.

PROCESS STAGE	WHAT HAPPENS	DESIGN / CONTROL PURPOSE
Vapour collection	Displaced vapour from loading points enters the recovery header.	Maintain a compatible, controlled path from gantry connections to the VRU inlet.
Adsorption	The inlet stream passes through the bed in adsorption service.	Retain hydrocarbon components while the treated carrier gas follows the selected outlet route.
Bed changeover	Valves redirect the incoming stream before the online bed reaches its selected switching criterion.	Maintain service continuity and prevent an uncontrolled breakthrough condition.
Vacuum regeneration	The isolated bed is depressurized under a controlled regeneration sequence.	Desorb retained hydrocarbons and restore the bed for its next adsorption period.
Separation and recovery	The vacuum discharge is routed through separation and the selected recovery stage.	Separate liquids where applicable and return recovered product to the selected destination.
Recycle / vent	Residual off-gas is recycled or routed to the designated discharge point.	Meet the agreed process, monitoring and environmental basis.

Reference Drawing:

Drawing No: VRU-LNS-1.0 PROCESS FLOW INFOGRAPHIC

4. TECHNICAL AND PERFORMANCE SPECIFICATIONS

The table below defines the standard product basis without fixing a project capacity or guaranteed emissions value. The VRU is configured using the actual vapour composition, loading pattern, collection-system pressure losses and the terminal's recovery objective. Equipment sizes, cycle settings and acceptance criteria are confirmed after review of those inputs.

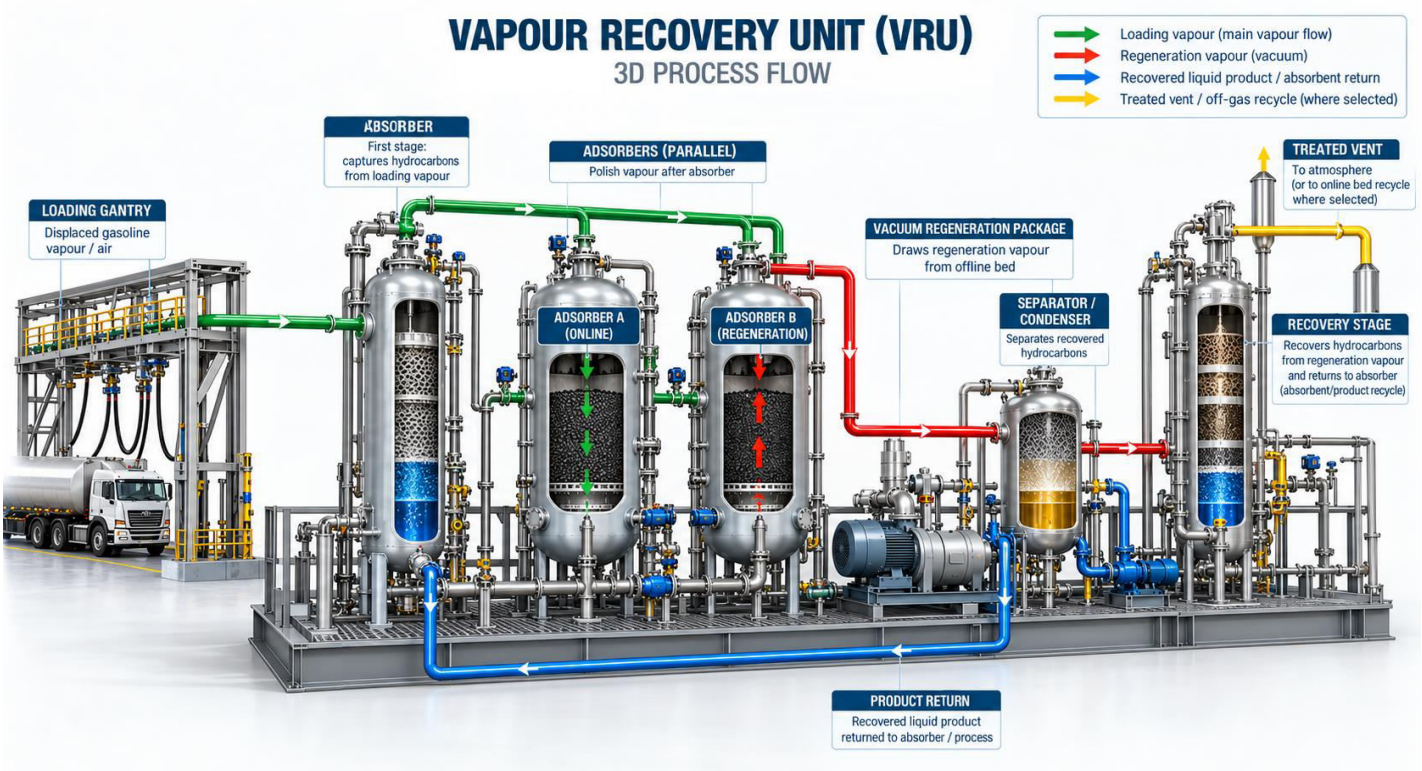
PARAMETER	STANDARD PRODUCT BASIS	ENGINEERING BASIS / SELECTION
Service	Gasoline and compatible hydrocarbon vapours from tanker loading.	Confirm vapour composition, concentration, temperature, moisture and contaminants.
Reference process	Activated-carbon adsorption with vacuum regeneration.	Confirm adsorbent, cycle and process arrangement for the service.
Vapour flow / loading duty	Custom-engineered for loading positions and operating cases.	Use simultaneous loading, displacement rate and collection-header losses.
Adsorber arrangement	Multiple carbon vessels arranged for alternating operation.	Bed count and sequence are selected for the cycle and availability objectives.
Regeneration basis	Controlled vacuum regeneration; purge / conditioning where selected.	Select the cycle based on process composition, carbon and target operating window.
Hydrocarbon recovery	Absorption or another selected recovery arrangement.	Define absorbent, product interface and return destination.
Treated vent performance	Defined against the agreed process and emissions basis.	Set and verify using the applicable test method and site acceptance criteria.
Pressure / vacuum design	Vessels and components selected for operating and upset cases.	Confirm design pressure, vacuum, relief and applicable construction requirements.
Materials / hazardous area	Selected for service, site conditions and area classification.	Finalize metallurgy, seals, electrical protection and instruments to project requirements.
Controls	PLC-based sequencing and monitoring may be supplied.	Confirm terminal interfaces, control philosophy and communication requirements.
Utilities	Selected to match the chosen vacuum and recovery technologies.	Confirm power, cooling, seal fluid, instrument air and purge requirements as applicable.
Testing / acceptance	Inspection and performance verification defined for the order.	Agree test conditions, measurement method and acceptance criteria before supply.

5. PERFORMANCE BASIS AND QUALIFICATION

Recovery performance is influenced by vapour composition, inlet concentration, flow variation, loading simultaneity, leakage in the collection network, carbon condition, cycle control and recovery-stage operation. A generic percentage cannot represent all terminal arrangements and should not be used as a guaranteed value.

The process design basis should state how the inlet and outlet streams will be measured, the operating condition during the test, and how transient loading events are treated. Where continuous monitoring or emissions reporting is required, the analyzer type, sample location and reporting method are defined for the facility and applicable regulation.

6. VAPOUR COLLECTION AND INLET CONDITIONING



The collection system connects the tanker or loading arm vapour-return point to the VRU. Its purpose is to convey the displaced vapour-air mixture while limiting leakage, liquid carryover and excessive pressure or vacuum at the loading interface. Header sizing and branch balancing are therefore integral to the VRU design, rather than separate details to be finalized after package selection.

Each loading connection, hose or arm, isolation valve and branch line should be reviewed for compatibility with the terminal's operating procedure. The header arrangement should account for the number of active bays, simultaneous loading, product changes, condensate drainage and the location of the package. Vapour collection devices and operating interlocks are coordinated with the gantry control philosophy.

Liquid droplets, dirt or foreign material entering the carbon beds can increase pressure drop, affect bed performance or complicate carbon handling. Inlet protection, condensate management, drains and inspection provisions are selected from the expected gas condition and site layout. The design review also checks that the loading system cannot unintentionally isolate the VRU while loading demand remains active.

COLLECTION ELEMENT	TYPICAL DESIGN CONSIDERATION
Gantry vapour connection	Compatible connection type, hose / arm arrangement, isolation and operating sequence.
Common header and branches	Flow distribution, pressure loss, simultaneous loading cases and provision for future bays.
Condensate management	Low points, knock-out or drain provisions, liquid carryover prevention and safe disposal.
Inlet protection	Strainer, filter, separator or other protection selected for the expected contaminant profile.
Pressure / vacuum control	Monitoring, alarms and protective measures coordinated with tanker and terminal limits.
Leak integrity	Flanged / threaded connections, flexible links and inspection access selected for vapour service.
Isolation and bypass	Valve locations and bypass philosophy defined to avoid untreated release during normal loading.

7. COLLECTION-SYSTEM DESIGN CHECKS

A well-integrated collection network is necessary for the adsorber to receive the vapour generated by loading. The following checks are typically completed before confirming the package duty:

- **Loading cases:**
  Normal and maximum product transfer rate, bay combinations and simultaneous operations.
- **Pressure envelope:**
  Header losses, tanker interface constraints, system relief philosophy and abnormal conditions.
- **Mechanical layout:**
  Routing, supports, flexible connections, drainage, access and hazardous-area equipment.
- **Operational coordination:**
  Loading permissive, VRU availability, fault response and safe stop sequence.

8. ADSORBER VESSELS AND ACTIVATED-CARBON SYSTEM

Activated carbon provides a high-surface-area adsorbent on which compatible hydrocarbon molecules are retained as the vapour stream passes through the bed. Adsorption capacity is finite. The process must therefore switch beds and regenerate the loaded bed before the selected breakthrough criterion is reached. Bed sizing and operating sequence depend on the loading profile, vapour composition, temperature, humidity and carbon characteristics.

The adsorber vessels are designed for the applicable adsorption pressure and regeneration vacuum. Internal screens, support grids and gas-distribution arrangements help direct flow through the carbon bed and limit channeling. Access provisions are included for inspection and carbon loading / removal. Temperature, pressure and differential-pressure connections support operation and maintenance, with continuous analyzers included when selected.

Carbon grade and bed depth are selected for the service, adsorption duty, regeneration method and operating cycle. Carbon is a service item: its performance can be affected by contaminants, moisture, temperature, aging, abrasion and incomplete regeneration. The supplier's approved carbon data and change-out criteria should be used for the selected application.

ADSORBER FEATURE	TYPICAL DESIGN BASIS
Vessel construction	Pressure / vacuum-rated shell and heads; material and corrosion allowance selected for service.
Carbon support	Retaining screens, support grids and access arrangement suitable for the selected adsorbent.
Gas distribution	Inlet and outlet arrangements selected to distribute flow across the active bed.
Carbon selection	Grade, particle size, working capacity and replacement basis confirmed for the vapour stream.
Bed switching	Automated isolation / routing valves with position feedback and sequence interlocks.
Monitoring points	Bed temperature, pressure and differential pressure; breakthrough monitoring where specified.
Maintenance access	Manways, fill / drain connections, lifting provisions and safe carbon handling access.

9. CARBON BED OPERATING CONSIDERATIONS

The online bed accumulates hydrocarbon during loading. Bed switching criteria may use a validated sequence, time, measured process condition or analyzer input, depending on the selected design. Regeneration completeness, pressure-drop trend and temperature behavior are reviewed together; a single indicator does not replace process-specific operating limits.

10. VACUUM REGENERATION PACKAGE

Vacuum regeneration lowers the pressure in the isolated adsorber so hydrocarbons retained on the carbon desorb and leave the vessel as a concentrated process stream. The vacuum system is selected to achieve the required regeneration profile while remaining compatible with the expected hydrocarbon composition, liquid carryover risk and utility conditions.

The regeneration sequence may include bed isolation, pressure equalization, vacuum pull-down, controlled purge or conditioning, and return to a ready state. Not every package uses the same steps: the sequence is selected for the carbon, process stream and recovery route. Valve timing and permissives must prevent cross-connection of the online and regenerating beds and prevent equipment operation in an incompatible line-up.

Vacuum technology may include liquid-ring or dry equipment, selected after reviewing process compatibility, maintenance, cooling and seal-fluid requirements. A separator or knock-out arrangement may be used to protect downstream equipment and manage condensed hydrocarbons or process liquids. The selected package includes the instruments and controls needed to monitor the vacuum cycle.

REGENERATION STEP	FUNCTION	TYPICAL MONITORING
Bed isolation	Removes the selected bed from the incoming vapour path.	Valve position, permissive and pressure equalization status.
Vacuum pull-down	Reduces bed pressure to promote desorption.	Bed vacuum profile, pump status and cycle time.
Purge / conditioning	Moves desorbed vapour and prepares the bed for return where used.	Purge flow / source, temperature and sequence status.
Discharge separation	Separates liquids or seal medium from the regeneration stream where applicable.	Separator level, temperature, pressure and drain status.
Bed recovery	Returns the regenerated bed to its selected ready condition.	Pressure / temperature condition and valve line-up.
Changeover	Transfers adsorption duty to the available bed.	Interlocks, position feedback and loading demand.

11. VACUUM PACKAGE EQUIPMENT

The vacuum package may include the vacuum pump, motor and coupling, seal-fluid circuit or cooling equipment, inlet separator, discharge separator, piping, isolation valves, instruments and local controls. Package boundaries are confirmed against the overall VRU arrangement so that condensate, seal fluid, cooling and drains have defined destinations.

12. HYDROCARBON RECOVERY AND PRODUCT RETURN

The concentrated regeneration stream is routed to a recovery stage selected for the application. In the reference gasoline-loading arrangement, a packed absorber may use gasoline or another compatible hydrocarbon liquid as the absorbent. The regenerated hydrocarbon is transferred into the liquid phase and returned with the absorbent to the selected storage or product destination.

A separator can collect condensed hydrocarbon or liquid entrained from the vacuum equipment before the stream enters the absorber. The absorber's liquid circulation, temperature, pressure and product return are designed around the available absorbent and terminal layout. The residual gas stream from the recovery stage may be routed back to the online carbon bed, subject to the selected process design and control philosophy.

Alternative recovery arrangements, such as condensation or other process-specific methods, may be assessed where product properties, utility availability or operating objectives support them. These alternatives require process evaluation; they are not interchangeable without checking material balance, recovery destination, operating envelope and emissions basis.

RECOVERY COMPONENT	ROLE IN THE PROCESS
Knock-out / separator	Collects liquid droplets or condensate from the regeneration stream, where required.
Absorber column	Provides gas-liquid contact to transfer recoverable hydrocarbons into the selected absorbent.
Absorbent circulation	Moves the selected liquid through the recovery stage at the process rate defined by design.
Product return	Routes recovered hydrocarbon / absorbent to the designated tank or product system.
Off Gas recycle	Returns residual gas to the online adsorber were included in the process design.
Alternative recovery stage	Condenser, separation or other evaluated methods selected for a particular service.

13. GAS HANDLING AND BLOWER SELECTION

A blower is not assumed to be required on every VRU. It is selected when the loading header and process pressure losses require assistance to convey the displaced vapour stream. Selection considers the full gas path, including header branches, inlet protection, bed resistance, valves and the terminal connection. Pressure control is coordinated with loading-system limits.

14. PROCESS CONTROL AND AUTOMATION

The control system coordinates loading demand, bed changeover, vacuum regeneration, recovery equipment and protective functions. A PLC-based package can provide automatic sequence control, local operator interface, alarms, event indication, operating modes and communications with the loading gantry or terminal system.

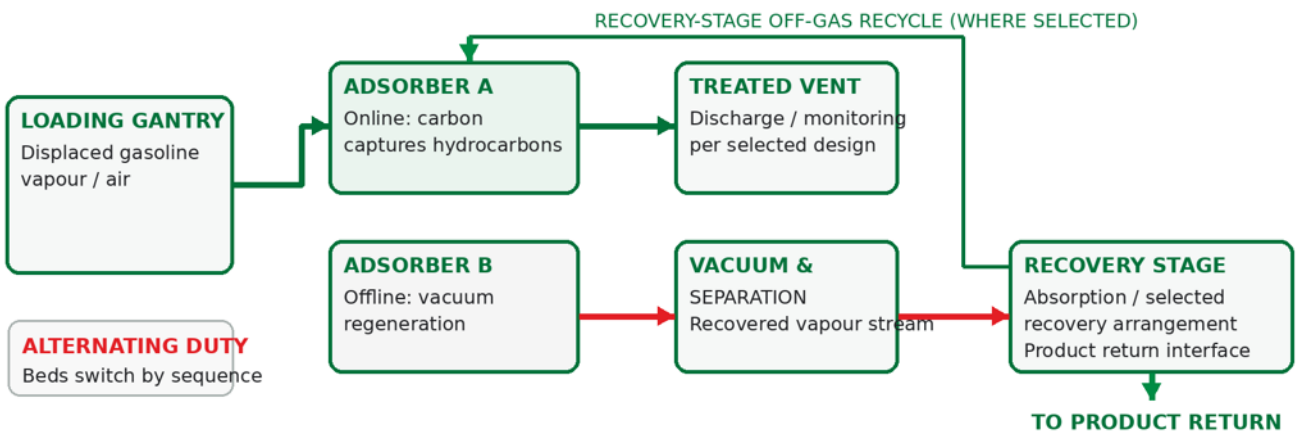
The sequence is developed so that each vessel's status is known before a valve transfer or equipment start. Interlocks can prevent incompatible valve line-ups, protect the vacuum equipment and block loading demand when the recovery unit is unavailable if that response is required by the terminal philosophy. The exact permissives and trip actions are agreed during detailed engineering.

CONTROL FUNCTION	TYPICAL IMPLEMENTATION
Loading request	Receives run demand / availability signals from the gantry or terminal.
Bed assignment	Identifies the online and regenerating bed and confirms valve line-up.
Adsorption monitoring	Tracks operating status and selected switching criteria for the active bed.
Regeneration control	Sequences isolation, vacuum operation, purge / conditioning and return to ready status.
Recovery control	Coordinates pumps, liquid circulation, separators and product-return status where applicable.
Alarm and trip handling	Annunciates process and equipment faults and initiates agreed protective actions.
Operator interface	Displays sequence state, equipment status, alarms, manual commands and maintenance mode.
Terminal communications	Provides agreed hardwired or network signals, common fault and shutdown interface.

15. TYPICAL OPERATING SEQUENCE

A representative operating cycle begins with an available package and a valid loading request. The online bed receives displaced vapour while the alternate bed completes regeneration. On a validated switching condition, the control system changes bed assignment, isolates the loaded bed and starts its regeneration sequence. When regeneration and conditioning criteria are met, that bed becomes available for the next changeover.

During start-up, shutdown, maintenance and upset conditions, the control system follows the agreed safe-state philosophy. Loading permissives, vent routing, isolation status, alarms and restart conditions are defined as part of the terminal integration rather than assumed from a generic package description.



16. INSTRUMENTATION, MONITORING AND SAFEGUARDS

Instrumentation is selected to show whether the vapour path, adsorber beds, vacuum package and recovery stage are operating within their approved design envelope. Monitoring may include pressure, vacuum, temperature, differential pressure, liquid level, equipment status and hydrocarbon concentration. The installed devices depend on the control philosophy, monitoring requirements and applicable site standards.

Protective measures may include high / low pressure alarms, vacuum protection, temperature alarms, equipment trips, emergency stop, isolation and terminal ESD interfaces. Relief devices, flame-protection equipment, gas detection and continuous emissions analyzers are selected only after the area classification, process hazards, applicable regulation and site standards are reviewed.

Monitoring plans should define alarm limits, instrument locations, calibration intervals, response actions and record keeping. Carbon-bed performance is assessed using the selected combination of outlet monitoring, regeneration indicators, bed temperature and pressure trends, and carbon condition checks. Limits and test intervals are established for the specific process and authority requirements.

MEASUREMENT / PROTECTION	TYPICAL APPLICATION
Header pressure	Indicates loading-header condition and supports high / low pressure response.
Bed pressure / vacuum	Confirms adsorption pressure and regeneration vacuum profile.
Bed temperature	Identifies abnormal temperature trends and supports process monitoring.
Differential pressure	Tracks restriction or fouling across the bed and inlet equipment.
Recovery-stage instruments	Level, flow, temperature and pressure points selected for liquid handling and absorption.
Hydrocarbon monitoring	Breakthrough or outlet measurement where specified by the process / compliance basis.
Emergency shutdown	Local E-stop and terminal trip interface coordinated with the facility cause-and-effect.

17. UTILITIES AND TERMINAL INTERFACES

Utility needs depend on the selected equipment. Electrical power is common; cooling, seal fluid, instrument air, purge gas, drains and liquid-transfer connections may be required by specific vacuum and recovery technologies. Utility quality, continuity and tie-in points are confirmed during application engineering.

UTILITY / INTERFACE	DESIGN CONFIRMATION
Electrical supply	Voltage, frequency, load, starting method, earthing and hazardous-area requirements.
Cooling / seal medium	Required only for selected equipment; define supply, return, quality and disposal.
Instrument air / purge	Confirm pressure, quality, consumption and whether purge is part of the selected sequence.
Drain / product return	Identify condensate, separator, seal-fluid and recovered-product destinations.
Terminal signals	Define loading demand, ready, fault, common alarm, permissive and ESD exchange.

18. SYSTEM CONFIGURATIONS AND PACKAGE SCOPE

LINESIG VRU packages can be arranged for a loading bay, a group of gantries or a centralized terminal system. A standard reference process uses alternating carbon beds, vacuum regeneration and a hydrocarbon recovery stage. Bed count, redundancy, recovery method, analyzer package and control interfaces are selected according to duty and availability requirements.

CONFIGURATION / SCOPE	DESCRIPTION
Packaged gantry VRU	Integrated skid for a defined loading area with package connections and local controls.
Centralized terminal VRU	Common recovery package served by an engineered collection-header network.
Adsorption / absorption	Reference carbon-bed process with vacuum regeneration, absorbent circulation and product return.
Alternative recovery stage	Condensation, separation or another evaluated stage where process conditions support it.
Typical package supply	Vessels, carbon internals, switching valves, vacuum equipment, selected recovery stage, instruments, PLC/control panel and skid piping as specified.
Options / by others	Gantry vapor piping, civil works, utility distribution, tank modifications, stack and site-wide ESD changes unless included in the order.

19. DESIGN SELECTION INPUTS

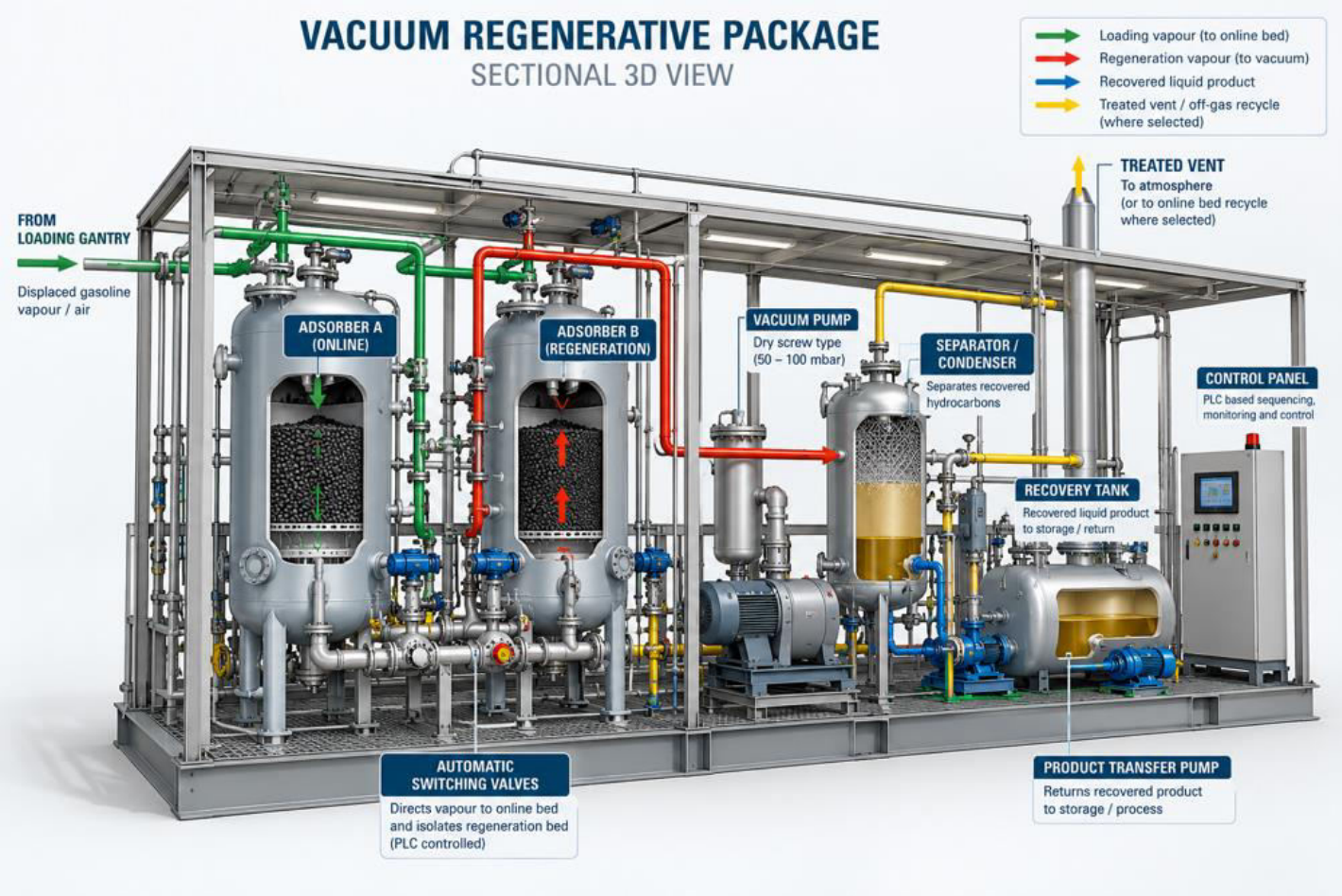
A complete selection basis allows the process package and collection system to be sized together. Preliminary selection should not be based on a nominal flow figure alone: maximum simultaneous loading, vapour composition, header pressure loss, product-return conditions and authority requirements can materially change the package arrangement.

INPUT	DATA REQUIRED FOR SELECTION
Vapour stream	Composition, concentration range, temperature, pressure, moisture and possible contaminants.
Loading profile	Product types, loading positions, rates, operating hours and simultaneous loading cases.
Recovery objective	Product destination, outlet criteria, monitoring method and test / acceptance basis.
Collection network	Tie-in points, pipe routing, estimated pressure loss, liquid carryover and existing equipment.
Site and utilities	Ambient conditions, hazardous-area classification, electrical supply, cooling and instrument services.
Operating philosophy	Availability target, redundancy, loading permissives, ESD integration, maintenance and future expansion.

20. OPERATION, INSPECTION AND MAINTENANCE

Reliable operation depends on maintaining the vapour collection path, correct bed switching, complete regeneration and stable operation of the recovery stage. Routine checks should follow the equipment manuals and approved site procedures. The operating team should review bed pressure and temperature trends, vacuum profile, valve feedback, pump condition, separator levels, leak integrity and any analyzer results provided with the package.

Maintenance planning typically covers carbon sampling or replacement criteria, valve and actuator checks, vacuum-pump service, seal-fluid or cooling-system maintenance, separator and filter cleaning, instrument calibration, control-system backups and inspection of flexible gantry connections. The interval and acceptance limits are set for the selected equipment and service conditions.



21. LINESIG VRU VALUE

The LNS-VRU product family is positioned as an integrated vapour-management solution for terminals handling gasoline and compatible volatile products. Its value comes from combining source collection, adsorption and regeneration, hydrocarbon recovery, controls and terminal interfaces in a coordinated package. The final configuration and measurable outcomes are established for the operating duty and acceptance basis.

CONTROLLED COLLECTION	RECOVERY-LED PROCESS	APPLICATION-BASED ENGINEERING	INTEGRATED PACKAGE
Designed to connect loading vapour sources to a defined treatment train.	Provides a route for recovering compatible hydrocarbons.	Capacity, process and safeguards are selected for the operating case.	Coordinates equipment sequence, monitoring and terminal signals.

All process capacities, outlet criteria, utility requirements, equipment materials, monitoring details, performance targets and supply boundaries are confirmed against the approved application data and purchase specification.



CLEANER INDUSTRY. HEALTHIER AIR. GREENER TOMORROW.

LINESIG vapour recovery solutions for responsible hydrocarbon handling.