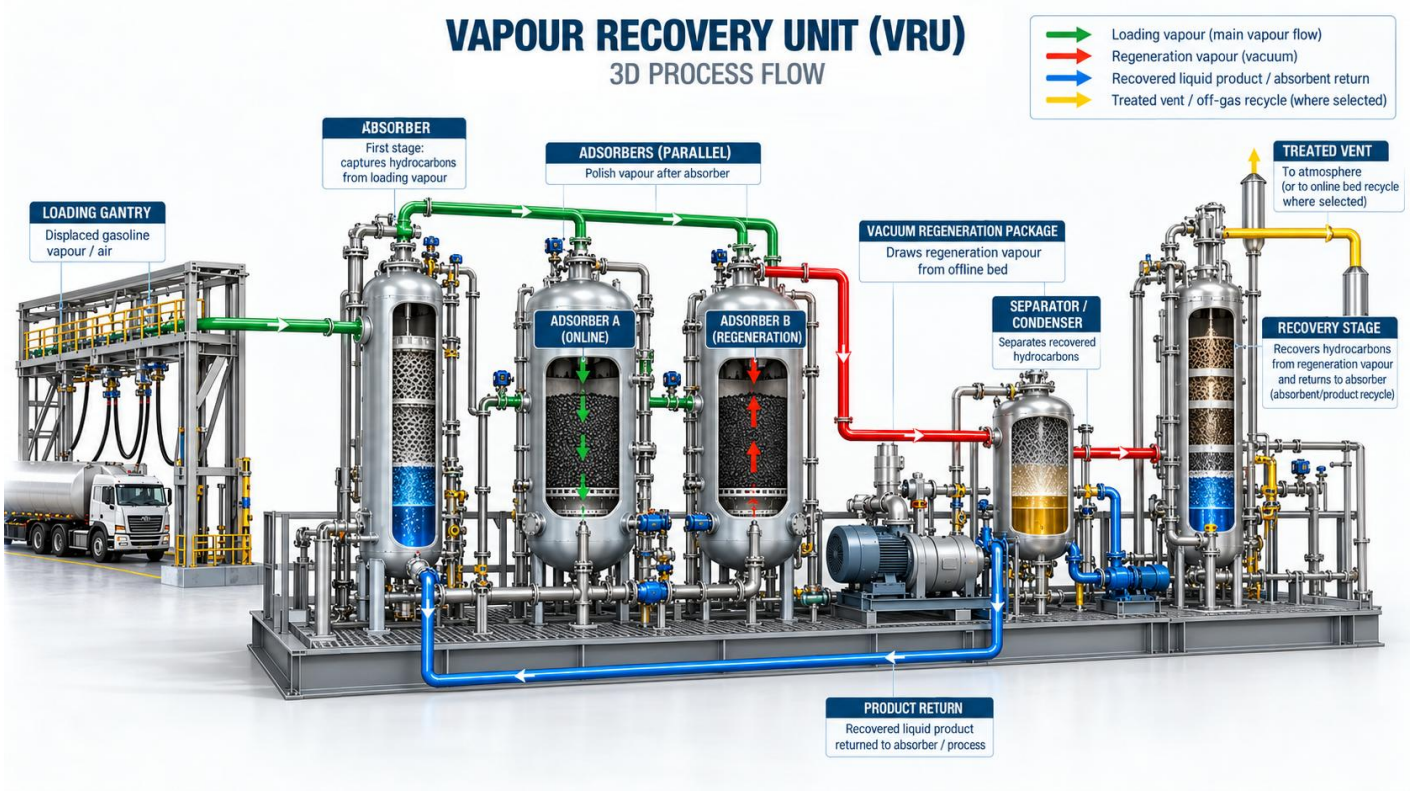
VAPOUR RECOVERY UNIT

OPERATION & MAINTENANCE MANUAL

Loading, Terminal & Industrial Vapour Service | Carbon Adsorption / Vacuum Regeneration / Wet Absorption

Document No.	**LINESIG-VRU-OM-001**
Revision	**0 - Preliminary Engineering Manual**
Reference Unit	**LNS-VRU-WET Product Family**
Service	**Gasoline and compatible hydrocarbon vapour recovery**
Design Vapour Flow Basis	**Application-specific; determined by site design**
Status	**General O&M Manual - project-specific data required before use**



IMPORTANT: **This Rev.0 manual is a general operating and maintenance framework for the LINESIG wet-type VRU product family, combining activated-carbon adsorption, vacuum regeneration and liquid-absorbent hydrocarbon recovery. Project-specific setpoints, equipment tags, vendor service intervals and site safety procedures must be completed and approved before use on any installed unit.**

Document Control

Item	Details
Document title	Vapour Recovery Unit - Operation & Maintenance Manual
Document No.	LINESIG-VRU-OM-001
Revision	0
Reference configuration	LNS-VRU-WET; configurable wet recovery arrangement
Applicable P&ID	Approved project P&ID (to be inserted)
Control platform	Project-selected PLC / control system
Manual status	General product-family manual; site data to be completed

Revision History

Rev.	Description	Prepared	Reviewed	Approved
0	Generalized wet-type VRU O&M framework Initial O&M manual framework and operating basis	Engineering	TBD	TBD

Manual Structure

- Safety and operating limits
- System description
- Operating modes and control philosophy
- Start-up / normal operation / shutdown
- Adsorber and regeneration operation
- Blower, vacuum pump and absorber operation
- Alarm and trip response
- Maintenance program
- Troubleshooting
- Inspection and records
- Spare parts and final handover data

1. Purpose, Scope and Intended Use

This manual provides a general operating and maintenance framework for **LINESIG** wet-type Vapour Recovery Units handling compatible hydrocarbon vapours from loading, storage and process interfaces. It is intended for trained operations, maintenance, instrumentation and electrical personnel. The approved project design and equipment manuals take precedence.

1.1 General Product-Family Design Basis

Parameter	Basis
Loading points	Project-dependent: gantry, tank, marine or process interfaces
Design vapour flow	Sized for each application and operating envelope
Loading / transfer duty	Defined by simultaneous operations and vapour displacement
Adsorption cycle	Selected from vapour duty, carbon and control strategy
Adsorbers	Multiple activated-carbon beds; quantity per design
Regeneration	Controlled vacuum regeneration; equipment type selected
Absorption	Wet absorber with compatible liquid absorbent
Vapour booster / blower	Provided only when header pressure losses require it
Vacuum pump	Vendor, capacity and motor selected for regeneration duty
Absorbent circulation	Pump duty and return system selected for application
Control system	Project-selected PLC / HMI or equivalent
Operating modes	As defined by approved control philosophy
Emission monitoring	Selected for applicable performance / permit criteria
Outlet criteria	Project-specific and subject to approved acceptance basis

1.2 Project-Specific Data / Engineering Holds

- Confirm the number and type of vapour sources, simultaneous operating cases, design flow and collection-header pressure limits for each installation.
- Confirm the vapour composition, absorbent compatibility, carbon loading, regeneration schedule and specified treated-vent performance.
- Verify line sizes, inlet protection devices, drains and vent routes against the approved P&ID and hydraulic calculations.
- Confirm valve actuator types, safe positions, instrument tags and the approved switching and interlock matrix.
- Verify the hazardous-area classification, electrical equipment protection and site-specific fire and gas requirements.
- Confirm equipment tag mapping, pump and blower duties, vendor manuals, control platform and approved commissioning settings.

2. Safety Requirements

Hydrocarbon vapour recovery involves flammable vapours, vacuum service, rotating machinery and hazardous-area electrical equipment. Only trained and authorized personnel shall operate or maintain the package.

2.1 Principal Hazards

- Fire and explosion from hydrocarbon vapours.
- Toxic or harmful vapour release from leaks or malfunction.
- Liquid hydrocarbon leakage and environmental contamination.
- Vacuum / pressure hazards in adsorbers and process piping.
- Hot surfaces and abnormal temperature rise in carbon beds or vacuum equipment.
- Rotating-equipment hazards from vacuum pumps, optional blowers and liquid pumps.
- Electrical and hazardous-area ignition hazards.

2.2 Mandatory Safe-Work Practices

- Apply site permit-to-work and lockout/tagout before maintenance.
- Gas-test and depressurize/isolate hydrocarbon-containing equipment before opening.
- Do not bypass ESD, high-temperature or critical interlocks solely to maintain throughput.
- Maintain grounding/bonding of vessels, skid and equipment.
- Use only hazardous-area-approved tools/equipment where required.
- Keep escape routes and access around the VRU clear.
- Drain hydrocarbon liquids only to the approved closed-drain/recovery system.

2.3 Source Safety Features to Retain

Feature	Purpose
Detonation flame arrester with temperature sensor	Isolate VRU from vapour collection system and detect abnormal heating
Carbon-bed temperature monitoring	Detect abnormal heat generation / adsorption heating
Selected vacuum vacuum pump protection	Monitor exhaust temperature, cooling-liquid temperature, vibration, discharge pressure and gearbox oil level
Spring-closing absorbent isolation valves	Fail-safe liquid isolation on defect / shutdown
Valve position monitoring	Confirm commanded position of main remote valves
Grounding	Bond vessels/skid to site grounding system

3. System Description

3.1 Process Overview

Hydrocarbon-rich vapour is collected from the applicable loading, storage or transfer sources and routed to the VRU. One or more activated-carbon beds treat vapour while designated beds undergo controlled vacuum regeneration. Concentrated desorbed vapours pass to a wet absorber, where a compatible liquid absorbent recovers hydrocarbons for return to the designated product system. Treated gas is routed to the approved outlet with monitoring where specified.

3.2 Major Equipment

Tag / Equipment	Function
Adsorber A	Activated-carbon bed used for adsorption / regeneration
Adsorber B / additional beds	Alternating adsorption and regeneration as configured
Wet absorber	Transfers desorbed hydrocarbons into compatible absorbent
Vacuum regeneration unit	Desorbs hydrocarbons from isolated carbon beds
Absorbent circulation pumps	Circulate absorbent and return recovered product
Vapour blower (optional)	Assists flow where collection pressure loss requires it
Flame protection (as specified)	Protects interfaces under approved hazard assessment
Outlet HC analyser (if fitted)	Monitors treated-gas hydrocarbons where required

4. Control System and Operating Modes

A project-selected PLC or equivalent automation system coordinates field instrumentation, sequencing, alarms and terminal interfaces. Valve feedback, equipment condition and process parameters are monitored as defined in the approved controls design.

Mode	Function
OFF / RESET	All pumps stopped and process valves in defined safe/standby positions; unit cannot process vapours.
ON	VRU cycles continuously regardless of loading demand, subject to PLC protections. Operator must ensure absorbent is available.
AUTO	Normal mode. Loading signals from connected vapour sources initiate/maintain operation and the PLC manages adsorption/regeneration and energy-saving logic.
MANUAL / MAINTENANCE - recommended	For commissioning/maintenance only; safety interlocks remain active unless formally bypassed under permit.

4.1 AUTO Permissives - Preliminary

- No plant ESD / local E-stop / fire & gas trip.
- At least one adsorber available.
- Critical valve feedbacks healthy.
- Vacuum regeneration system available and protective functions healthy.
- Vacuum-pump cooling flow/temperature healthy.
- Suction blower available.
- Wet absorber liquid inventory within approved operating band.
- Absorbent system available.
- Flame arrester temperature normal.
- Emission analyzer healthy or approved maintenance bypass active.

5. Start-Up Procedure

5.1 Pre-Start Inspection

- Confirm mechanical completion and no open maintenance work.
- Verify drains, vents, manholes and process connections are secured.
- Confirm activated carbon is loaded as specified and access covers secured.
- Confirm absorbent source and return paths are available.
- Check wet absorber liquid level within approved operating range.
- Confirm electrical power, control power and instrument air (if applicable).
- Confirm regeneration-pump utilities and cooling where required.
- Verify all emergency stops reset and ESD/F&G healthy.
- Confirm loading or process control interface, where applicable.
- Verify no outstanding critical alarms.

5.2 AUTO Start Sequence

1. Select AUTO at the approved operator station.
2. PLC performs master permissive check.
3. One carbon bed is assigned ADSORPTION READY and the other REGENERATION READY / STANDBY.
4. Upon valid loading demand, start the vapour blower, where installed and establish acceptable vapour-header pressure.
5. Open and prove the selected adsorption path.
6. Permit vapour flow from the approved collection sources.
7. Regenerate the alternate carbon bed as required by sequence/load logic.
8. Monitor vent hydrocarbons where specified, bed temperatures, vapour-header conditions, vacuum and absorber liquid level.

6. Normal Operation

6.1 Adsorption

The online bed receives hydrocarbon-laden vapour. Hydrocarbons are retained on activated carbon and treated air leaves the top of the bed to the clean-air vent. Operators shall monitor bed temperature, pressure, valve status and vent hydrocarbon concentration.

6.2 Bed Changeover

- Alternate bed must be proven READY before changeover.
- The PLC shall prevent a configuration that allows uncontrolled bypass of untreated vapour.
- The online bed is isolated before connection to the vacuum system.
- Changeover may be initiated by nominal cycle timing, calculated loading or abnormal emission condition according to final PLC logic.

6.3 Regeneration

The isolated carbon bed is connected to the designated vacuum regeneration package. Reduced pressure desorbs retained hydrocarbons. Pump capacity or speed is controlled according to the approved regeneration sequence and vendor requirements. Vacuum limits and cycle settings are project-specific.

6.4 Vacuum Break / Return to Ready

9. Complete the programmed final regeneration/purge step if enabled.
10. Isolate the regenerated bed from the vacuum system.
11. Use the controlled vacuum-break/equalization path.
12. Confirm bed pressure returns to the approved READY band.
13. Verify valve feedbacks before declaring the bed READY.

7. Equipment Operating Guidance

7.1 Vapour Blower (if installed)

- Required for applicable vapour collection duty to overcome collection-system pressure losses.
- Preferred control is VFD pressure control from the vapour header.
- Excessive vacuum shall reduce blower speed and at high-high vacuum shall trip/unload the blower according to final logic.
- Blower fault should inhibit new loading if safe vapour collection cannot be maintained.

7.2 Vacuum Regeneration Pump / Package

Check	Operating Expectation
Cooling / utility supply	Healthy before and during regeneration
Utility temperature	Within vendor-approved range
Exhaust temperature	Within vendor-approved range; HH trips pump
Vibration	Normal; HH trips pump
Discharge pressure	Within vendor-approved range; HH trips pump
Lubricant / seal system	Within vendor-approved limits
Drive / control readiness	Ready, remote and fault-free

7.3 Wet Absorber / Recovery Column

- Maintain stable liquid level for effective absorption.
- High-high level shall stop/abort regeneration or isolate incoming rich vapour according to final C&E.
- Low-low level shall protect pumps and inhibit regeneration if absorbent inventory is insufficient.
- Confirm absorbent supply and return isolation paths remain available.

7.4 Clean-Air Vent / Analyzer

- HC analyzer shall remain in service during normal operation.
- High emission should initiate alarm and bed-change request.
- Persistent high-high emission should trigger the approved loading-inhibit/VRU-trip response.
- Analyzer bypass, if provided, must be controlled and recorded.

8. Shutdown Procedures

8.1 Normal Shutdown

14. Stop accepting new loading demand.
15. Complete or safely terminate active loading according to terminal procedure.
16. Allow blower run-on if configured until header conditions are stable.
17. Complete or safely terminate active regeneration.
18. Stop the vacuum package and liquid pumps in the approved sequence.
19. Return valves and beds to approved standby condition.
20. Record abnormal observations and active alarms.

8.2 Emergency Shutdown

21. Remove loading permit / signal terminal that VRU is unavailable.
22. Isolate vapour admission to the VRU.
23. Stop suction blower unless final ESD philosophy requires a specific temporary action.
24. Stop the vacuum regeneration equipment in accordance with the ESD logic.
25. Close fail-safe absorbent isolation valves and stop liquid pumps.
26. Place adsorber switching/vacuum valves in approved safe positions.
27. Latch ESD until the initiating cause is cleared and manual reset is authorized.

9. Alarm and Trip Response

Condition	Operator Response / Automatic Action
Carbon bed temperature H	Prepare/confirm alternate bed; investigate heating.
Carbon bed temperature HH	Affected bed isolated; package/load response per C&E; do not reset until investigated.
Vapour header pressure H/HH	Check blower, header restrictions and loading activity; loading may be inhibited.
Excessive header vacuum	Blower speed reduced; LL/HH vacuum protection may trip blower.
Vent HC concentration H	Bed change request / inspect carbon performance.
Vent HC concentration HH persistent	Loading inhibit or VRU trip per final C&E.
Vacuum pump thermal / mechanical trip	vacuum pump trips and regeneration aborts.
Vacuum package utility fault	vacuum pump trips.
wet absorber level HH	Stop/abort regeneration and check liquid return path.
wet absorber level LL	Protect liquid pump and inhibit regeneration if required.
Flame arrester temperature HH	Immediate VRU isolation / ESD.
Valve proof failure	Sequence hold; do not force continuation without approved maintenance procedure.

10. Preventive Maintenance Program

The general operating practice assumes that the unit is designed for automatic operation but recommends regular checks for unusual noise, vibration, temperatures and liquid levels, together with annual vibration testing with frequency analysis for rotary equipment. Exact vendor maintenance intervals must be inserted from certified manuals.

Frequency	Maintenance Activity	Status
Each shift / daily	Visual leak check; abnormal noise/vibration; review alarms; check wet absorber level; check vacuum pump/blower status; check vent analyzer status	Recommended
Weekly	Inspect valve indication, local instruments, grounding/bonding, drain/vent integrity, panel alarms	Recommended
Monthly	Exercise non-cycling isolation valves as permitted; inspect flame arrester condition externally; inspect filters/strainers; review trends	Recommended
Quarterly	Functional test selected shutdown/alarm loops; inspect actuator air/electrical connections; check analyzer calibration status	Recommended
6-monthly	Detailed rotating-equipment inspection per vendor; electrical terminal inspection where permitted; clean control-panel filters if fitted	Vendor/site dependent
Annually	Vibration test with frequency analysis on rotary equipment; full ESD/C&E test; analyzer calibration; inspection of carbon-bed performance	Annual vibration specifically equipment/site-specific; other tasks project/vendor dependent

11. Equipment Maintenance Guidance

11.1 Activated-Carbon Beds carbon adsorption vessels

- Trend bed temperatures and vent emissions for signs of reduced adsorption performance.
- Check for abnormal pressure drop or suspected channeling/fouling.
- Do not open the vessel until isolated, depressurized, gas-freed and covered by confined-space/permit procedures.
- Carbon replacement frequency is not stated in the supplied documents and shall be based on performance, carbon supplier guidance and operating history.

11.2 Vacuum Regeneration Equipment

- Follow equipment vendor manual for lubrication, oil level, clearances, service intervals and permitted fluids.
- Keep cooling circuit clean and available.
- Trend vibration, exhaust temperature, discharge pressure and motor/VFD load.
- Investigate repeated failure to achieve regeneration vacuum before returning the bed to service.

11.3 Vapour Blower (if installed)

- Inspect bearings/coupling/drive per final blower vendor manual.
- Trend speed, load and pressure differential.
- Check vapour header for blockage if high speed is continuously required.
- Do not alter pressure setpoints without verifying the allowable pressure limits of the connected vapour sources.

11.4 Wet Absorber / Liquid Pumps

- Maintain liquid inventory above minimum pump requirement.
- Inspect pump seals/sealless containment according to selected vendor.
- Check suction/discharge isolation and non-return valves.
- Confirm liquid pumps duty mapping in final manual before issue.

12. Troubleshooting Guide

Symptom	Possible Causes	Recommended Checks
High vapour-header pressure	Blower unavailable/undersized; blocked header/flame arrester; too many simultaneous loadings	Check blower status/speed, header DP, loading count, valve positions
Excessive vacuum at source/header	Blower speed too high; control-loop fault; restriction at vapour source	Reduce speed through control logic; verify PT and PID tuning
Vent HC concentration high	Carbon bed saturated; wrong valve lineup; bed not fully regenerated; analyzer fault	Change bed, verify valve proof, regeneration vacuum, analyzer calibration
Vacuum pump temperature above limit	vacuum pump fault; air leak; vacuum valve not open; atmospheric path not closed	Check VFD, pressure trend, valve feedbacks, leakage
Wet absorber high liquid level	Cooling flow/temperature issue; abnormal load; vendor mechanical problem	Check cooling flow/temp, discharge pressure and vendor diagnostics
Wet absorber low liquid level	Return pump/valve unavailable; excessive liquid inflow	Check liquid pumps, return path, level instrument
wet absorber level LL	Insufficient absorbent supply; leak; pump issue	Check source tank, supply valve, pump suction and level signal
Frequent valve proof faults	Actuator/limit-switch issue; low air/power; mechanical sticking	Check supply, actuator stroke, feedback switches and valve condition
Frequent ESD trips	Recurring process or instrumentation fault	Use first-out/event log; investigate initiating cause before reset

13. Operating Records

- Daily throughput / active loading bays.
- Bed cycle count and adsorption/regeneration durations.
- carbon adsorption vessels temperature trends.
- Regeneration vacuum profile.
- Vacuum pump speed, loading, temperature and vibration trends.
- Wet absorber levels and circulation-pump operating hours.
- Vent HC analyzer readings and calibration records.
- Trips, first-out cause and corrective action.
- Maintenance work orders and replaced parts.

14. Spare Parts Framework

Category	Recommended Spare Basis
PLC / I/O	Final CPU/module spare philosophy per client criticality
Transmitters / switches	Critical pressure, temperature, level and flow devices or compatible calibrated spare
Valve actuators / solenoids / limit switches	Critical switching valve spares based on final valve list
Vacuum regeneration package	Vendor-recommended service kits, seals, fluids and filters as applicable
Blower	Vendor-recommended bearing/seal/service kit
Liquid pumps	Vendor-recommended seal/containment/service kit
HC analyzer	Consumables / calibration accessories per analyzer vendor
Gaskets / seals	Approved hydrocarbon-compatible materials for maintenance connections
Fuses / relays / power supplies	Selected panel critical spares

15. Data Required Before Final O&M Issue

- Final approved P&ID and line/valve tags.
- Final alarm/trip setpoints and delays.
- Final blower vendor data and motor rating.
- Confirmed liquid pumps duties and vendor manuals.
- Certified vacuum equipment vendor manual and maintenance schedule.
- Final activated-carbon supplier datasheet and replacement criteria.
- Final absorber operating level setpoints.
- Final hazardous-area classification.
- Final ESD/SIS architecture and reset philosophy.
- Final HC analyzer vendor data, range and calibration procedure.
- Final terminal/TAS interface and loading-inhibit philosophy.
- Site-specific emergency, permit-to-work, LOTO and environmental procedures.

16. Recommended Final O&M Appendices

Appendix	Content
A	Approved P&IDs
B	Equipment datasheets
C	Instrument Index and calibration sheets
D	Valve List
E	Cause & Effect Matrix
F	Alarm & Trip Schedule
G	PLC / HMI operating screens
H	Electrical SLD and wiring diagrams
I	Vendor manuals: vacuum equipment, blower (if fitted), pumps, analysers, actuators
J	FAT / SAT records
K	Preventive maintenance forms
L	Recommended spare parts list

17. Operator Quick Reference

Situation	Immediate Action
Normal AUTO operation	Confirm VRU available, one bed online, alternate bed ready/regenerating, blower and vacuum pump healthy.
High emission	Confirm bed change; check regeneration and analyzer.
Bed HH temperature	Do not continue affected bed; follow C&E/ESD response.
Vacuum pump trip	Regeneration aborts; keep affected bed NOT READY until fault cleared.
Blower trip during loading	Remove/inhibit loading permission if vapour collection cannot be maintained.
Plant ESD	Verify package is isolated/stopped; investigate first-out cause; reset only when authorized.

18. Manual Review and Approval

Role	Name	Signature	Date
Prepared by			
Process Engineering			
Instrumentation & Control			
Electrical			
Maintenance			
HSE / Functional Safety			
Approved by			

Engineered Flow. Protected Systems. Assured Performance.