INSTALLATION · COMMISSIONING · MAINTENANCE MANUAL

LRF / ZRFQ / WRF Hot Air Furnaces

Document YX-MAN-HTA · Revision 1.0 · Issue 2026-11 · www.yxboiler.com · English

This manual covers installation, commissioning, operation and maintenance of the LRF vertical biomass hot air furnace, the ZRFQ direct-fired oil and gas hot air generator and the WRF clean-air heater. It applies to units from 0.12 MW to 11.6 MW (100,000 to 10,000,000 kcal/h) with outlet air at 120–350 °C. It is written for the site engineer, the commissioning technician and the maintenance team who take over the ductwork, burner, controls and refractory after handover.

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1. Scope and model coverage

The family has three architectures: LRF, a vertical biomass furnace with a refractory combustion chamber and horizontal air-to-air exchanger; ZRFQ, direct-fired with the burner firing into the air stream; WRF, an indirect clean-air heater with a stainless exchanger and HEPA final filtration, so flue gas and process air never mix. The range is in the capacity selection guide.

Model	Capacity	Outlet air	Fuel	Typical duty
LRF-15	0.17 MW · 150,000 kcal/h	120–300 °C	Wood chip, pellet, rice husk	Grain and timber drying
LRF-60	0.70 MW · 600,000 kcal/h	150–350 °C	Biomass, moisture ≤ 25%	Brick and tile tunnel dryer
LRF-120	1.40 MW · 1,200,000 kcal/h	150–350 °C	Biomass, moisture ≤ 25%	Spray dryer process air
ZRFQ-30	0.35 MW · 300,000 kcal/h	150–350 °C	Natural gas, LPG, diesel	Direct food and feed drying
ZRFQ-240	2.80 MW · 2,400,000 kcal/h	150–350 °C	Natural gas, LPG, diesel	Sand, mineral and aggregate drying
ZRFQ-600	7.00 MW · 6,000,000 kcal/h	200–350 °C	Natural gas, heavy oil	Large tunnel and kiln air supply

Model	Capacity	Outlet air	Fuel	Typical duty
WRF-20	0.23 MW · 200,000 kcal/h	120–250 °C	Gas or oil, indirect	Pharmaceutical clean air
WRF-100	1.16 MW · 1,000,000 kcal/h	120–250 °C	Gas or oil, indirect	Food spray drying, HEPA air

Each unit is designed and built to GB/T 16508 and TSG G0001 where pressure parts are present; third-party inspection on request. Excluded: ductwork downstream of the outlet flange unless ordered, site electrical work beyond the terminal box, gas piping and fuel storage upstream of the inlet flange, and third-party duct insulation. Drawings, the product pages for LRF, ZRFQ and WRF, and the manual library govern where they are more specific.

2. Site and utility requirements before delivery

Confirm every item below before the unit leaves the works; a missing utility delays start-up, and a duct route never checked against the fan curve cannot be fixed on site without new ductwork.

Item	Requirement	Tolerance / notes
Foundation / plinth	Reinforced concrete, level, cured 28 days, mass ≥ 1.5 × unit mass	Level ±3 mm over the base frame; grout after alignment
Clearances — exchanger side	Free length ≥ 1.2 × tube bundle length	Bundle withdrawal for cleaning and re-tubing
Clearances — burner side	1.5 m swing clearance, 0.8 m access all round	ZRFQ and WRF burner door opening
Combustion air	Clean, 1.2 × stoichiometric demand, 20 °C design	Duct from outside if the room exceeds 35 °C
Dilution air	Filtered, 20–35% of total outlet flow at full turn-down	Take from a clean zone, not from the dryer return
Fuel gas	20–50 kPa at the inlet flange, steady supply, calorific value per contract	Regulator and filter by others upstream
Fuel oil	Diesel 0.5–2.0 MPa at the burner; heavy oil preheated to 90–110 °C	Ring main with return, filter 40 µm
Biomass fuel	Chip or pellet 5–30 mm, moisture 8–25%, ash ≤ 5%	Fines below 3 mm ≤ 15%; no stone or metal
Electrical supply	380 V ±5%, 3-phase, 50 Hz; neutral and earth at the terminal box	Voltage unbalance ≤ 2%; separate isolator per motor

Item	Requirement	Tolerance / notes
Earthing	Earth resistance ≤ 4 Ω, bonding of casing, duct and burner	Test certificate before energising
Flue and chimney	Draught −20 to −60 Pa at the flue outlet; height per drawing	No shared chimney without a draught stabiliser
Drainage	Floor drain at the ash pit and condensate point	Slope 1:100 to the pit

A standard unit has no feed water circuit, so hardness, pH and oxygen limits do not apply. Where an optional evaporative tempering chamber is fitted, use softened water at hardness ≤ 0.03 mmol/L and pH 8.5–9.5; above 6 t/h equivalent on that circuit, add a deaerator.

Provide three air changes per hour at full rate and keep the combustion air inlet below 35 °C. Brace the flue independently of the casing. Measure draught at minimum and maximum firing rate: a flue sized for full rate can over-draught at low rate and lift the flame off the diffuser.

3. Installation sequence

1. Check the delivery against the packing list: casing, exchanger bundle, burner, cabinet, refractory and duct flanges. Photograph any damage before signing.
2. Set the unit on its plinth on the marked lifting lugs only, grout the base frame and check level to ±3 mm. Acceptance: no rocking, anchor bolts finger-tight before grouting.
3. Install flue and chimney on their own support. Acceptance: flue moves 2 mm by hand at the joint, no load on the casing.
4. Erect the supply duct from the outlet flange back towards the dryer, supported at 2.5 m centres with sliding shoes at expansion joints. Acceptance: duct moves no more than 3 mm when pushed by hand.
5. Fit the dilution damper and actuator; the damper must fail open on power loss. Acceptance: 90 s full stroke to both stops without binding.
6. Install the outlet sensor 1.0 m from the outlet flange at duct centre, and the high-limit capillary 0.5 m upstream of the first branch. Acceptance: probe at marked depth, pocket filled with heat-transfer paste.
7. Connect the gas train or oil line to the burner inlet with filter, regulator, pressure switches and two safety shut-off valves in drawing order. Acceptance: all joints soap-tested at 1.5 × working pressure.
8. For LRF, erect hopper, feed screw and ash conveyor, set the grate and check the ash door seal. Acceptance: screw turns freely by hand, gasket compresses evenly.
9. Cast the combustion chamber refractory to the drawing, keeping expansion joints free of castable. Acceptance: anchors fully embedded, 3 mm fibre joints open, no bridging.

10. Wire the cabinet to the terminal box and check motor rotation with couplings removed. Acceptance: correct rotation, no rubbing, no-load current within nameplate.
11. Fit the airflow proving switch with tappings five diameters apart. Acceptance: switch changes state at 70% of design differential pressure.
12. Insulate the duct in two staggered layers and clad, then pressure-test at 1.5 × working static for 30 minutes. Acceptance: no gap above 2 mm, leakage ≤ 2% of design flow.
13. Run the fan 30 minutes and record vibration and bearing temperature. Acceptance: ≤ 4.5 mm/s RMS, bearing rise ≤ 40 K.

Lifting and rigging

Lift only on the four marked lugs; never sling under the exchanger bundle, burner or duct flanges. A loaded LRF-120 weighs about 9 t with the centre of gravity towards the combustion chamber. Use a spreader beam, keep personnel clear, and never lift a unit whose refractory has cured less than seven days.

Expansion joints and anchors

The casing grows about 4 mm per metre of height at 300 °C. Fix the base only and let the flue and supply duct slide. Fit a bellows between the outlet flange and the first support, and never anchor both ends of a straight run without an expansion joint. The tube bundle is fixed at the cold end and free at the hot end — do not clamp the hot tubesheet.

Ductwork and static pressure budget. Size the main duct for 10–14 m/s, branches for 6–8 m/s. Compute the budget with the duct and static pressure calculator before ordering the fan; the example is a ZRFQ-240 at 2.8 MW and 48,000 m³/h.

Component	Design loss (Pa)	Note
Heater casing and exchanger	250	Clean bundle, from the fan curve
Burner combustion head	80	ZRFQ only; zero for WRF
Supply duct, 40 m at 12 m/s	320	0.8 Pa/m at 300 °C
Fittings, bends and transitions	90	15% of straight-run loss
Balancing dampers, two	100	Half-closed allowance
Final filter bank F9, dirty	220	Change filters at 350 Pa
Outlet plenum and louvres	60	Fixed loss
Design margin 15%	168	Applied to the subtotal
Fan external static, selected	**1,500**	1,288 Pa calculated, 10% flow margin

4. Commissioning and handover

There is no water-side pressure part on a standard unit, so test the air casing and duct instead: 1.5 × 6 kPa casing design pressure, 9 kPa, held 30 minutes, then soap-test every flange and sight glass. An optional water coil is hydro-tested at 1.5 × design pressure for 30 minutes.

Dry out new refractory before any fired run: hold 150 °C for 6 hours, raise at 25 K/h to 600 °C, hold 4 hours, with the chamber open to atmosphere. A faster dry-out cracks the castable and voids the refractory warranty. Then clean the tubes, close the doors and check the flame pattern at minimum rate.

Set the burner on the contracted fuel: 3.5–5.0% O2 for gas, 4.0–6.0% for oil, 6.0–9.0% for biomass, CO below 50 ppm at the stack. Tune the outlet loop for 60 s settling and under 5 °C overshoot after a 10% damper step. Record fan current, casing surface temperature and outlet static pressure as the baseline.

Interlock	Simulated condition	Expected result
High-limit thermostat	Heat the outlet sensor to setpoint + 20 °C	Burner trips, alarm shows, dilution damper drives open
Airflow proving switch	Stop the supply fan, or close the main damper	Fuel valves close within 5 s, lockout, no restart without reset
Purge incomplete	Interrupt the purge timer at 50%	No ignition; controller returns to purge
Gas low pressure	Reduce inlet to 70% of set pressure	Lockout within 3 s, alarm
Gas high pressure	Raise inlet to 110% of set pressure	Lockout, both shut-off valves close
Flame failure	Close the manual cock during firing	Shutdown within 3 s flame-failure response time
Emergency stop	Press the E-stop	All fuel valves close; fan runs on for 3 min to cool the casing
CO monitor, direct-fired	Inject test gas to 100 ppm in the outlet duct	Alarm at 50 ppm, trip at 100 ppm

Run 4 hours at 50% and 100% load, then 24 hours at the duty point. Log hourly: outlet temperature, damper position, O2, stack temperature, fan current, bearing temperature, vibration and refractory skin temperature. Handover documents: this manual, as-built drawings, wiring diagram, burner data sheet, dry-out record, interlock test sheet, fan balance report, duct leakage test sheet and the signed 24-hour record.

5. Normal operation

Start-up from cold. Check the ash pit is empty and the hopper holds four hours of fuel. Open the fuel manual valve, confirm gas pressure in band, start the supply fan and wait for airflow proof. Purge five chamber volumes, never less than 30 s at full airflow. Light at minimum rate, hold two minutes, then release to modulating control. On LRF, run the feed screw slowly until the fire establishes.

Start-up from hot standby. Keep the fan at 30% flow and the outlet at 150 °C. Before resuming, confirm the refractory skin is above 200 °C, check the scanner is clean and purge 30 s. A hot start skips warm-up but never skips the purge.

Parameter	Normal band	Action if outside
Outlet air temperature	Setpoint ± 5 °C	Check damper position and sensor
Dilution damper	20–80% open at duty	Below 15% means the unit is at its limit
Combustion O2	Gas 3.5–5.0%, biomass 6.0–9.0%	Trim air damper; check for casing leaks
Stack temperature	Gas 180–220 °C, biomass 160–200 °C	Rise above 250 °C means fouling
Casing surface temperature	≤ 60 °C at 300 °C air	Repair insulation or cladding
Fan current	≤ nameplate, steady	Check filter loading and belt slip
Bearing temperature	≤ 80 °C, rise ≤ 40 K	Grease, then investigate alignment
Vibration velocity	≤ 4.5 mm/s RMS	Clean and rebalance the impeller
Filter differential pressure	80–350 Pa	Change at 350 Pa

Normal shutdown. Reduce to minimum rate, hold three minutes to burn off the grate, stop the burner and run the fan ten minutes to cool the casing. Close the fuel manual valve, stop the fan, close the dilution damper, and on LRF run the ash conveyor empty.

Emergency shutdown. Press the E-stop: fuel valves close and the fan continues three minutes. Do not open the chamber door above 200 °C, and do not restart before the cause is found and the chamber purged. For a flue fire, close the fuel, keep the fan running and never use water on the refractory.

Lay-up over 30 days. A standard unit has no water side. Dry lay-up is the default: clean ash and soot, dry the refractory with a 150 °C hold for four hours, close doors and flue dampers, and place 5 kg of desiccant per cubic metre of casing volume; replace saturated desiccant monthly. For an optional tempering chamber, drain and apply wet lay-up with a nitrogen blanket or 200 ppm inhibitor.

6. Maintenance schedule

The tables are the minimum. Severe duty — high-ash biomass, or a food dryer running 24 hours — halves every interval. Keep the energy consumption figures with the log so drift in stack temperature or fan current shows against the baseline.

6.1 Daily (each shift)

Task	What to check / acceptance	Tool or reference	Who
Record outlet temperature and damper position	Setpoint ± 5 °C; damper 20–80% at duty	HMI trend, shift log	Operator
Read O2 and stack temperature	O2 in band; stack within 20 °C of baseline	Flue gas analyser, once per shift	Operator
Check flame signal and flame colour	Stable signal above the controller minimum; no yellow tips	Sight port, HMI	Operator
Check fuel pressure at the train	Within 20–50 kPa gas; oil pressure per burner sheet	Pressure gauge	Operator
Empty ash pit, check ash bin seal (LRF)	Pit below the grate line; no air leak at the door	Visual, hand test	Operator
Feel fan for vibration and heat	No new noise; bearing housing below 80 °C	Hand, infrared thermometer	Operator
Inspect refractory through the port (LRF)	No glowing cracks or fallen pieces	Visual at low rate	Operator

6.2 Monthly

Task	What to check / acceptance	Tool or reference	Who
Clean or replace intake and process filters	Final differential pressure ≤ 120 Pa clean; no torn media	Vacuum, new elements	Maintenance
Check V-belt tension and pulley alignment	Deflection 10–15 mm per 1 m of span, measured at mid-span; pulleys within 1 mm	Rule, straight edge	Maintenance
Grease fan bearings	Two strokes of lithium EP2; purge old grease	Grease gun	Maintenance
Clean UV scanner and ignition electrodes	Glass clear, gap 2.5–3.5 mm, insulator uncracked	Soft cloth, feeler gauge	Burner technician
Soap-test gas train joints	No bubble growth at any joint or diaphragm vent	Leak detection fluid	Maintenance
Exercise dilution damper and linkage	Full stroke in 90 s; actuator arm tight; fail-open on power loss	HMI command, watch blade	Instrument technician
Inspect refractory for cracks and spalling (LRF)	Cracks ≤ 3 mm acceptable; larger to be patched	Visual, crack gauge	Refractory crew

6.3 Quarterly / semi-annual

Task	What to check / acceptance	Tool or reference	Who
Clean the air-to-air exchanger tubes	Stack temperature back within 20 °C of baseline; no visible ash bridging	Compressed air 0.4 MPa, nylon brush	Maintenance
Clean fan impeller, check balance	Vibration ≤ 4.5 mm/s RMS after cleaning; balance grade G6.3	Vibration meter, ISO vibration severity limits	Maintenance
Test high-limit thermostat with heat source	Trips at setpoint + 20 °C, ± 3 °C; burner stops, damper opens	Heat gun, thermometer	Instrument technician
Test the airflow proving switch	Trips at 70% of design differential pressure, within 5 s	Test tee, manometer	Instrument technician
Measure CO and NOx at outlet (direct-fired food drying)	CO ≤ 50 ppm, NOx ≤ 75 ppm at 3% O2	Certified analyser	Service engineer
Inspect duct insulation and cladding	Surface ≤ 60 °C; no crushed or missing sections	Infrared camera	Maintenance
Check expansion gaps at the hot tubesheet	Gap within 2 mm of the calculated 10 mm per 3 m at 280 K rise	Feeler gauge, drawing	Service engineer

6.4 Annual shutdown inspection

Task	What to check / acceptance	Tool or reference	Who
Inspect and pressure-test the exchanger bundle	No through-leak; flue CO_2 in process air below 0.2% on WRF	Pneumatic test 1.5 × casing pressure, CO_2 meter	Service engineer
Full refractory survey and repair (LRF)	Lining thickness ≥ 85% of drawing; no exposed anchors	Hammer tap, depth probe	Refractory crew
Dry out repaired refractory	150 °C for 6 h, then 25 K/h to 600 °C, hold 4 h	Dry-out curve, thermocouples	Commissioning engineer
Replace fan bearings and check alignment	Shaft alignment within 0.05 mm; no axial preload	Dial gauge, laser aligner	Maintenance
Overhaul gas train, prove valve tightness	Internal leak test: no pressure rise in 60 s on either valve	Valve proving record	Burner technician
Re-test duct leakage	≤ 2% of design flow at 1.5 × working static	Blower door, manometer	Maintenance
Test every interlock in Section 4	All eight interlocks pass; signed sheet filed	Interlock test sheet	Instrument technician

Task	What to check / acceptance	Tool or reference	Who
Certify final filters, HEPA stage on WRF	H13 integrity test pass, ≤ 0.01% penetration	Particle counter, DOP test	Cleanroom contractor

Record keeping

Keep log sheets, analyser printouts and interlock test sheets for three years; keep refractory dry-out and exchanger test records for the life of the unit. Any reading outside the band in Section 5, any crack beyond 3 mm and any repeat burner lockout go to the site engineer the same shift.

7. Troubleshooting

Symptom	Likely cause	Check	Remedy
Outlet temperature below setpoint with the damper closed	Capacity limit or fouled exchanger	Stack temperature and fuel rate vs baseline	Clean the bundle; reduce dryer load or add dilution capacity
Outlet temperature oscillates ± 15 °C	PID too aggressive, or sensor in a dead zone	Damper and sensor trend	Retune to 60 s settling; centre the sensor in the duct
Burner locks out at ignition	Purge incomplete, weak spark, or low gas pressure	Purge timer, electrode gap, inlet pressure	Reset purge, set the gap to 3 mm, restore pressure
Flame established then lost	Dirty UV scanner, or flame lifted by over-draught	Scanner window, flue draught at low rate	Clean the scanner; fit a draught stabiliser
High stack temperature, normal outlet	Fouled tubes or baffle damage	Stack vs baseline, tube inspection	Clean the tubes, replace damaged baffles
Smoke or CO at the outlet (direct-fired)	Rich mixture, or combustion products leaking into process air	O2 and CO at the outlet; casing joints	Trim excess air to 4% O2; seal the casing and re-test CO
Fan vibration above 4.5 mm/s	Dirt on the impeller, worn bearing, or belt misalignment	Vibration spectrum, bearing temperature	Clean and rebalance; replace bearings; realign pulleys
Ash carry-over into the exchanger (LRF)	Excess grate speed or low secondary air	Grate speed, secondary air, ash bed	Reduce feed, raise secondary air, reset the grate
Refractory glowing or hot casing spot	Cracked castable or failed anchor	Infrared scan, tap test	Shut down, patch or re-cast, dry out per Section 6.4

8. Spare parts and service

Hold these first-year spares on site; double them where two units share a duty.

Item	Quantity	Notes
Intake and final filter elements	2 sets	Match the drawing frame size
V-belt set	2 sets	Replace as a matched set
Fan bearings	1 set per fan	Grease and seals included
UV scanner and ignition electrode	1 each	Consumable, keep one spare
Flame safeguard relay	1	Same part number as fitted
High-limit thermostat	1	Set to drawing value before fitting
Airflow proving switch	1	Check set point after fitting
Refractory castable	200 kg	Same grade as original lining
Grate bars and ash door gasket (LRF)	10 bars, 2 gaskets	Fast-wearing items
Gas train solenoid coils	1 pair	Match the valve class
Dilution damper actuator	1	Fail-open type, 90 s stroke

Consumables: lithium EP2 grease, leak detection fluid, filter media, patching mortar and heat-transfer paste. Order by model, serial and drawing number, all on the nameplate and the matched burner and gas train data sheet; a control cabinet order also needs the cabinet serial. We acknowledge within one working day, diagnose remotely within two, and attend site within five working days in mainland China, by arrangement elsewhere. Book service through the contact page.

9. Document control

Rev	Date	Change
1.0	2026-11	First issue for LRF, ZRFQ and WRF families

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This manual is generic to the family. For the version written against your unit — burner curve, duct layout, refractory drawing and serial settings — send the model and serial number through the

contact page.

Request the site-specific manual