FLR-CropDrying
HIGH PERFORMANCE VENTILATION SYSTEMS

Installation Manual

Main Air Ducts

Contents

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Introduction

1. Flach & Le-Roy Ltd are Ventilation Engineers serving the arable farming industry. The company was formed in 1993 by Richard Flach and Owen Le-Roy who have each served this industry for over 25 years.
2. Flach and Le-Roy Ltd provides ventilation systems design services to main turnkey providers of crop-drying and storage facilities as well as direct to the UK and overseas farming communities. Our design philosophy is based upon practical experience and sound knowledge of the latest advances in ventilation technology.
3. Our production capability includes the manufacture, supply and installation of timber–formed floors, walls and air ducts for drying and storing grain and vegetables. We also supply fans, gas heaters and ancillary equipment enabling us to provide whole crop-drying and storage installations within the UK and abroad.
4. Flach & Le-Roy's reputation is founded on design know-how, quality workmanship, use of high-quality timber and equipment and the ability to design and install high performance crop-drying systems in both brand-new facilities and in existing building conversions.
5. At Flach & Le-Roy we are wholly committed to the success of our current and future customers. We listen carefully to our customers; try to understand their needs and work hard to make their crop-drying decisions as well-informed as possible. Put simply, at Flach & Le-Roy we put our customers' success ahead of all other business considerations.
6. As of July 2009 Flach & Le-Roy have designed and delivered over 1000 installations to their UK and overseas customers.

General Product Description

7. **Drive-on Ventilated Floors**. Flach & Le-Roy Drive-on ventilated floors (Fig 1) provide today's hardworking farms with a flexible, reliable and efficient crop-drying and storage system with the capacity to handle the throughput of today's modern harvesting machinery with ease.

Fig 1

Drive-on Ventilated Floor

8. Unlike constant flow drying machinery Drive-on floors can be self-installed by farm staff thereby reducing the overall cost to the farmer. The Company provides palletised parts clearly marked for ease of assembly and our self-install package includes a training day, stand-by support and tool-hire services if required. A full installation service is also available and our teams of fully trained professionals have many years experience which enables us to install flooring quickly and efficiently to a high standard of finish (Fig. 2).

9. Flach & Le-Roy floors are designed to a high specification using top-grade hardwood and softwood boards in short lengths for ease of maintenance. Our

hardwood top boards are manufactured from selected Keruing timber which we purchase kiln-dried prior to moulding in order to minimize shrinkage. This treatment significantly reduces the risk of a ventilation mesh becoming detached during service. The timber used in our optional softwood top boards and in all our bearers is slow growing Baltic, Russian or Scandinavian timber giving excellent wear characteristics.

Fig 2

Installing the Drive-on Floor

10. The timber bearers are kiln-dried beams, wider at the main bearer for added stability and strength. Floor loading is permitted up to 5 tons axle weight per pneumatic tyre giving a wide tolerance for a variety of farm vehicles. The floor is of modular design enabling the bearers to be adjusted on-site to allow for variations in the concrete floor level; this is of particular benefit when converting an existing building to a drying and storage facility.
11. The floor design is a result of Flach & Le-Roy's continuous development over several years and is optimised to maintain the required airflow and restrict airspeed to less than 10 metres per seconds (2000 ft/min). Plywood sealing strips

are inserted at the board ends to provide a positive, long-lasting air seal to minimise air-loss along the length of the floor. These strips are designed to avoid any tendency to split or shrink as is often the case with seal blocks.

12. Galvanised steel ventilation meshes are installed at close, even intervals (Fig. 3, which makes the floor ideal for drying difficult crops such as grass seed at shallow depths. The meshes lie below the board surface to minimise the risk of damage from farm machinery and are wide enough to provide a good overall floor-free area without being too wide to risk pressure damage from wheels. Flach & Le-Roy floors can be supplied with or without mesh inserts making them suitable for use with a wide range of crops.

Fig 3

Galvanised Steel Ventilation Meshes

13. A Flach & Le-Roy floor can be viewed as a long-term valuable asset. In uncertain times if the farming policy should change a Flach & Le-Roy floor can be lifted, if required, offering a saleable asset and freeing an intact building for an alternative use.

14. **Main Air Ducts**. Flach & Le-Roy Main Air Ducts are manufactured using the same high-grade timber described above and are supplied with optional hardwood or softwood frames and/or hardwood or softwood ply cladding (Fig 4 & 5). Our ducts range from a height of 2.44 metres to 4.88 metres high and can be made

available to suit timber floors, above and level floor laterals, and boxes. If required building dividers can be provided to connect from the duct walkway to the roof of the building and tailor-made designs, including wide-end sections and walkway-mounted plenum chambers to house the fans are our speciality.

Fig 4

Central Main Air Duct with Plenum Chamber

Fig 5

Internal Structure of Main Air Duct

15. All Flach & Le-Roy air ducts are carefully designed and constructed to ensure the maximum flexibility for directed airflow and minimal air leakage joints and fittings ensuring little or no loss of efficiency in drying performance. Outlets with easy to use sliding doors are spaced between each frame providing maximum drying flexibility (Fig 6).

Fig 6

Outlets with Sliding Doors

Fig 7

Letterbox Main Air Duct

16. **Letterbox Main Air Ducts**. FLR Letterbox main air ducts (Fig 7) are manufactured using the same high-grade timber as in our floor products and supplied with optional hardwood or softwood frames and superior Indonesian and Malaysian hardwood ply.

17. The markets for onions and potatoes demand the highest quality products and this can only be achieved consistently with controlled in-store ventilation of the crop.

18. Letterbox main air duct systems can provide precise monitoring of both air and crop temperature and humidity to enable the accurate control of high output modulating heaters, fans and air control louvres thus ensuring optimum storage conditions.

19. Ducts can be supplied with remotely controlled outlets operated from walkway level or ground level. The duct side-ply can be extended to the roofline with timber framing to form a walkway-mounted air-mix and fan plenum. The fans can be mounted either above or below the duct walkway or on the end of the duct in a traditional fan house. We can also supply motorised or spring-operated recirculation doors and louvres, insulated intake louvres and covers, insulated exhaust louvres and fridge systems and support.

20. **Self-Shedding Walling**. FLR walling uses stress-graded timber and cladding options in hardwood or softwood ply are available. Standard wall storage heights range from 2.44 metres up to 3.66 metres. We can also supply one-off designs to greater heights to suit customer requirements.
21. The walling is designed for maximum strength to accommodate level or surcharge fill depending on need.
22. Double-sided walling is available to enable the farmer to build a crop divider. The self-shedding wall design is both cost-effective and easy to clean and maintain.
23. Some farmers may wish to opt for DIY installation to cut cost. We calculate and supply everything from timber, ply-cladding, steel anchor brackets with expansion bolts or resin anchors to the hire of specialist equipment and one day's training to get you started.

Fig 8

Self Shedding Walls

Fig 9

Self Shedding Walls

24. **Axial and Centrifugal Flow Fans. Control Panel and Gas Burners.** In general, ventilating cereals in bulk with 100 cfm/ton at the correct relative humidity level will reduce the moisture content by up to 0.5% over 24 hours. Typically, therefore, a 30kw centrifugal fan (Fig 10) will be suitable for drying a 300 ton batch of grain when specified at the correct operating pressure.

Fig 10

Centrifugal Fans

25. Historically fan drying rate has been dependent on a number a factors, i.e. air temperature and relative humidity, seed size and initial crop moisture content. However, in order to provide today's farms with the capability to handle the throughput of modern harvesting machinery FLR also takes account of the customer's anticipated floor-loading rates and ultimate crop depth when recommending fan sizes.

Fig11

Twin Axial Flow Fans

26. We supply and install a wide of range of centrifugal and axial-flow fans (Fig 11) to meet system requirements and these range between low-pressure axial units used for drying vegetable crops to high-pressure centrifugal and multi-stage axial fans used for drying cereals and seed crops. All our fans can be delivered complete with wire guards, silencers, mounting feet, bellmouth entries and dampers as required.

27. Our automatic control panels (Fig 12) can be supplied complete with door interlocking isolators, fan contactors, fan selector switches, remote stop terminals, louvre controls, fan-run hours-meters, time clocks, thermostatically controlled panel anti-condensation heater and interlocked burner electrical supply terminals or sockets. In general all circuits are protected by modern circuit-breaker technology.

Fig 12

Control Panel & Fan Room

28. Our fan controllers provide either intermittent fan operation which sense either/both air temperature and/or air relative humidity and control the drying fan within pre-set limits or we can supply an upgraded version which also provides 24-hour continuous operation and controls a fully modulated gas heater (Fig 13).

29. We have three ranges of gas heaters: (1) basic mobile units which can supply from 150k BTU/hr to 900k BTU/hr, (2) industrial specification permanent burners which can supply from 250k BTU/hr to 4.0 m BTU/hr and (3) industrial specification positive pressure burners which maintain the high levels of safety associated with permanent burners but without imposing any pressure differential on the main fan. Our industrial specification burners are supplied as standard complete with electronic temperature/humidity controller, galvanised steel casings, pressure regulator, auto-pilot start, twin main flame solenoids, modulating valve, power failure protection, fan failure protection, overheat thermostat and flame failure protection.

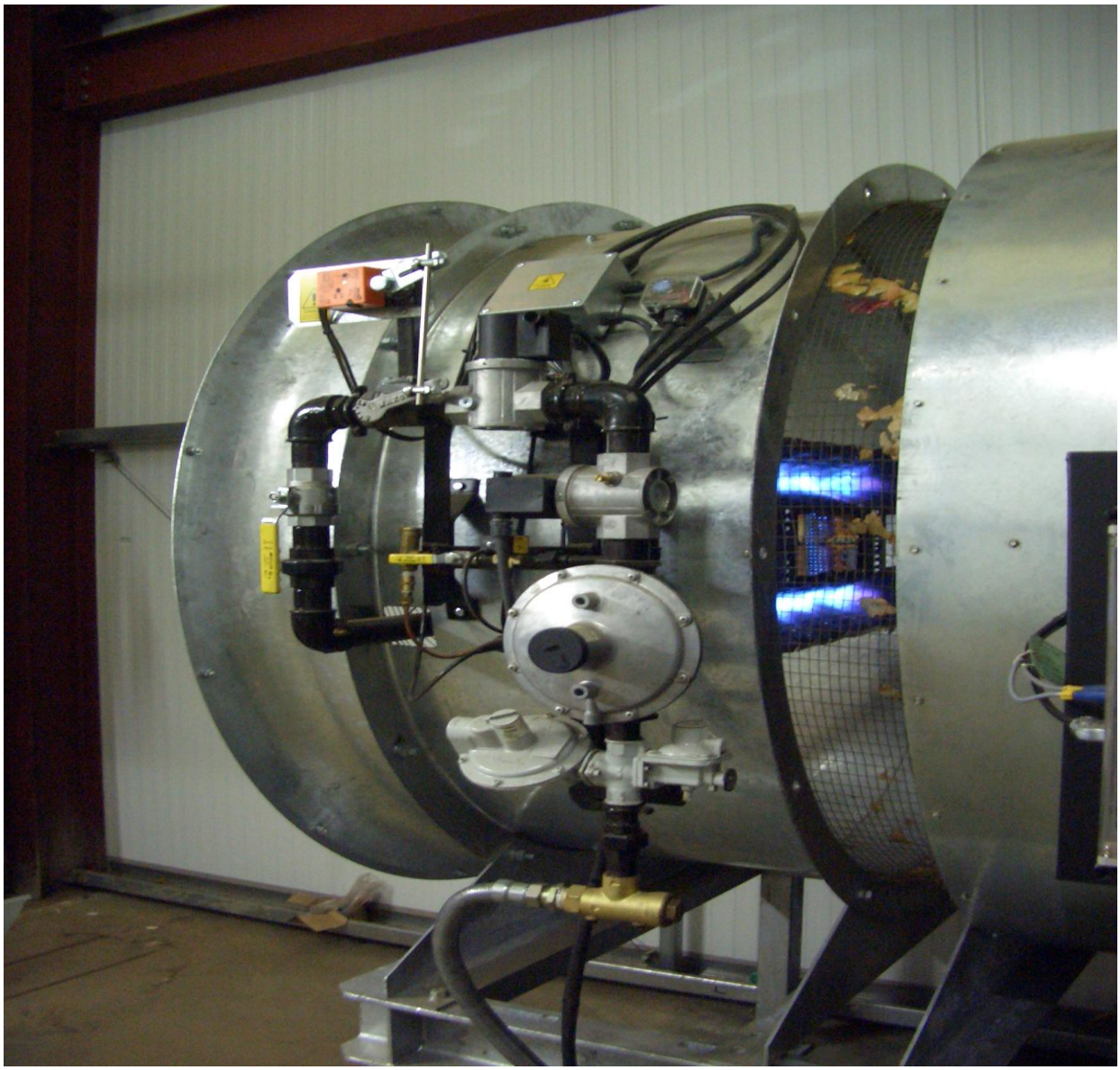

Fig 13

Fully Modulated Gas Burners

30. **Health and Safety** The following safety guidelines are provided for employees and contractors working on behalf of Flach & Le-Roy and recommended to self-install customers and their staff engaged in the installation of Flach & Le-Roy crop-drying products. Any special safety issues that need to be brought to the installing erectors' notice should be communicated by the customer prior to each day's work commencing, e.g. if a grain dust hazard will be present during grain filling and loading the supervising erector must be made aware of any planned activity in the vicinity of the ongoing installation.
31. **General.** Safety helmets will be worn by installation erectors in hard hat areas on the site.
32. Scissor lift and/or Scaffold towers are to be used when working at height above 2.44 metres.
33. Offload timber from the delivery vehicle using a forklift for which a valid licence is held.
34. Place the offloaded timber in close proximity to its final position and stack it clear of the ground on timber battens.
35. Adhere to the installation sequence as portrayed in this manual unless the directed otherwise by the supervising erector.
36. This guide has been concerned with establishing conditions of crop moisture content and temperature in bulk drying and storage units, so that the required degree of stability is established which renders crops 'safe' for the appropriate storage period. Of even greater importance is the necessity for this function to be carried out safely by those who operate or have reason to visit your installations.
37. By contrast with some agricultural activities - which by their very nature can be described as 'risky' - it would appear that grain drying units could reasonably described as 'passive'. In spite of this, records show that in England and Wales between 1973 and 1994 no fewer than 62 deaths were associated with grain drying and storage units. This unacceptably high level arises in part because many activities in grain drying and storage units are carried out by one person working alone. Seldom is anyone in a supervisory capacity present to stop or correct unsafe practices or to render first aid when an accident occurs. This factor emphasises the importance of thorough training regarding the dangers inherent in the working environment and in the functions performed. Most of

the accidents which have occurred in grain drying and storage units in recent years can be attributed to the following causes:

i. Respiratory disorders

ii. Electrocution.

iii. Structural failures

iv. Submersion in flowing grain.

v. Falls

vi. Submersion in bridged grain.

vii. Accidents with machinery.

38. The majority of bulk drying and storage facilities to which this guide relates are not equipped with pits and silos/hoppers which empty under the influence of gravity. However awareness of the risk of entrapment in flowing or bridged grain is important for all grain store operators.

39. The hazards against which the operators of bulk grain drying and storage units must be safeguarded include :

40. Grain dust - the Control of Substances Hazardous to Health Regulations 1988 (the COSHH Regulations) attribute a Maximum Exposure Limit (MEL) to grain dust. This reflects the very hazardous nature of the dust which may contain bacteria, fungi and pesticide residues. A particular problem with grain dust is that many of the particles are very small, enabling them to penetrate deep into the structure of the lungs where they can cause lasting damage and a number of respiratory disorders. The MEL value attributed to grain dust under the COSHH Regulations is 10mg/m3 for an 8-hour time weighted average. There is also a 10 minute maximum exposure value of 30mg/m3. These values must never be exceeded and steps must be taken to ensure that exposure values are reduced below these values ‘so far as is reasonably practical’. Hence as part of your COSHH Assessment you will need to assess the levels of dust to which operators are exposed, in your store.

41. One operational benefit of Flach and Le-Roy drive-on floors, by contrast with above floor ducted systems is that workers do not need to spend time installing/recovering ducts in a dusty environment, while the store is being filled/emptied. However dense dust is created when loading/unloading drive-on floors. Enclosing the operator in a tractor/loader cab which is equipped with a

properly maintained forced air filtration unit is an example of an 'engineering control' which complies with the requirements of the COSHH Regulations. A record sheet should be completed and attached to your COSHH Assessment to verify that air filters have been changed in accordance with the manufacturer's instructions. As a last resort respiratory protection equipment can be used to provide the necessary protection. Professional guidance should be sought on the selection of suitable RPE which should take into account the hazardous nature and small particle size of grain dust.

42. Structural failures-the number of accidents resulting from structural failures within grain stores which have been designed for the purpose, is small. However there is considerable risk associated with using general purpose buildings for crop storage when the stored product transmits loads to structures which were not designed to withstand them. British Standard 5502: 1987 Design of Buildings and Structures for Agriculture provides recommendations, guidance and technical data for appropriately qualified persons concerned with building design and construction. It also contains information regarding loads and pressures exerted by stored agricultural products.

43. Load bearing equipment manufactured by Flach & Le-Roy is designed by professional structural engineers using appropriate factors of safety. Regretfully accidents have occurred when structures built by others without the necessary skills have failed. The areas of greatest concern are:

    1) Failures arising from the re-erection of second hand equipment. For example, we do not advise re-erection of second-hand main air ducts without professional guidance. Proper understanding of the stresses involved when they are loaded on one side only is essential to ensure the appropriate fixing to concrete floors.

    2) Structures must only be subjected to the loads which they were designed to withstand. Retaining structures which have been designed to be level loaded must not be surcharged. The maximum safe loading height should be indicated on the manufacturer's installation sign.

44. Falls - the increased height of many grain drying and storage installations gives emphasis to the need to keep stairways and catwalks, including associated hand and guard-rails, in good condition. Many falls involve the use of ladders, so frequently used routes within bulk grain drying and storage units should be equipped with fixed ladders or staircases, not unsecured ladders. Deaths

occurred on two occasions when ladders being used to gain access to a silo and a grain vehicle slipped, resulting in fatal falls. When working with ladders remember that:

1) A second person standing at the foot of a ladder to prevent it slipping is only effective with ladders less than about 6m long.

2) Ladders should extend at least 1m above the landing place or the highest rung in use, unless there is a suitable handhold to provide equivalent support.

3) Only use ladders at their most stable angle. A slope of four units 'up' to each one from the base (75° from horizontal on firm and level ground) is recommended.

45. Accidents with machinery - fortunately many of the items of machinery which have caused accidents/fatalities are not used in bulk grain drying and storage units. However they are not hazard free:

1) Accidents have occurred when automatic fan controllers have started fans unexpectedly. Hence before working on fans ensure that power supplies are isolated.

2) Problems have arisen when fans have started while operators have been working within main air ducts. When this happens it can be impossible to open exit doors as a result of the force upon them caused by the air pressure. Hence the provision of an isolator to stop the fan from within the duct is essential. Mammals, including man, will not experience difficulty in breathing at the pressures found within air ducts, (after all it doesn't harm the mice!)

3) Access doors into main air ducts are often located adjacent to fans. This emphasises the need for both fan inlets and outlets to be adequately guarded.

46. Loading vehicles, including telescopic materials handlers, should only be operated by suitably qualified drivers. Employers should ensure that operation of such vehicles is restricted to authorised operators and that authorisation is not given unless the operator is adequately trained or experienced. In the case of drivers employed in this task since 1st April 1989, adequate training is a statutory requirement.

47. Electrocution - the Management of Health and Safety at Work Regulations 1992 require employers to make a suitable and sufficient assessment of the risks to the health of employees. Such an assessment should include risks arising from the use of electrical equipment. The particular legal requirements relating to the use and maintenance of electrical equipment are contained in the Electricity at Work Regulations 1998. These Regulations require certain safety objectives to be met, eg inspection and testing. However they do not stipulate the frequency of this requirement. This is to enable qualified electricians to select a schedule appropriate to the risk and avoids the need to have precautions imposed that may not be relevant to a particular work activity.

48. An incident in which a worker was electrocuted in a grain store illustrates the need for compliance with the Regulations. The worker supported himself on a roof truss as he leaned over a silo to see if it was full. Unknown to him the truss was 'live'. When he touched the silo it provided a path to earth and he was electrocuted. Inspection revealed that when the lights in the building were switched on, faults in the wiring caused parts of the metal framework of the building to become live. The electrical system incorporated an earth leakage circuit-breaker which failed to perform its function because the earth wire had broken away from its earthing connector. It is recommended that such safety devices are tested at least once a month and any malfunction investigated and rectified urgently, before the circuit is used again.

49. Submersion in flowing crops - although the risk of submersion in flowing crops in unlikely to be a hazard encountered by operators of the bulk drying and storage units to which this guide relates, the hazard is so great that reference to it is justified.

50. Submersion in bridged grain - grain which has been inadequately dried may lose its free flowing characteristics as a result of the development of moulds and fungi, leading to caking. When bins and towers containing such grain are emptied by gravity, bridging can occur resulting in the formation of 'caverns' beneath the bridged crop.

    1) Accidents have occurred in two ways. The weight of operators who climb into bins to investigate the reason for the interruption of grain flow may be sufficient to cause the bridge to collapse; this can cause burial in the crop, resulting in suffocation. Secondly, operators entering bins and silos containing bridged grain at ground level may cause the grain to collapse on

them, again resulting in suffocation. Such accidents could be avoided by ensuring that crops are properly dried and cooled prior to storage so that deterioration resulting in bridging does not occur.

2) Should bridging occur in spite of precautions, assistance must be obtained. Attempts must only be made to clear bridges from outside of the bin by operators wearing safety harnesses appropriately anchored. It may be possible to make the bridge collapse with the use of a long pole or by dropping heavy weights onto the surface of the crop. Equipment used in this operation should be secured by ropes to the top of the bin to facilitate their retrieval and eliminate the temptation to enter bins to recover them.

Main Air Ducts

Timber duct parts identification Figs 1 - 6

1. Plywood end plate
2. Joining strip – for 18 mm ply use noggins
3. Ply side sheets
4. Handrail supports
5. Top side sheet (not used with 2.0 m high ducts)
6. Handrail stringer 70 mm x 45 mm planed softwood – plane top corners to 45 degrees after installation
7. Access door assembly)
8. Access door frame) All pre-assembled
9. Access door furniture) All pre-assembled
10. 50 mm x 50 mm corner flashing
11. Access ladder
12. Ladder fixing brackets
13. Ladder hand grabs
14. Softwood rubbing timber

15 & 16.Plywood squares (extended plywood squares to seal where the duct extends beyond the floor

17. 45 mm nails at 100 mm spacing
18. Duct walkway ply
19. Duct walkway ply to side ply sealing stringer 70 mm x 45 mm planed softwood
20. Handrail support bracket
21. Handrail support bracket fixing – drive screw
22. Duct holding down anchor bracket
23. Expansion bolt
24. Plywood slide guide
25. Plywood air control slide
26. Coach screw
27. Main Duct Frame
28. 50mm x 50mm softwood rail (Side Duct)
29. Frame Fixer (Side Duct)

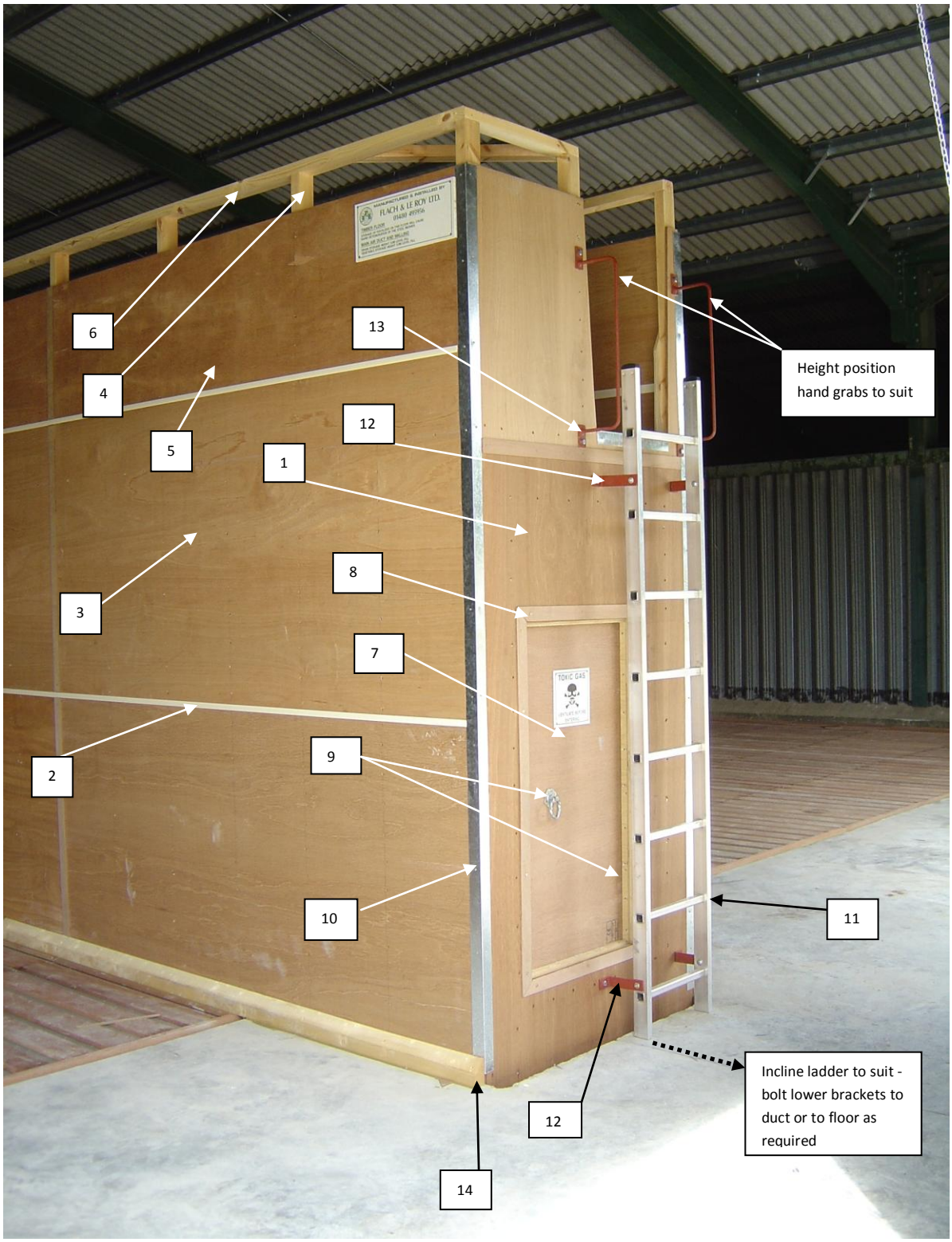

Fig 1

Mani Air Duct Parts List

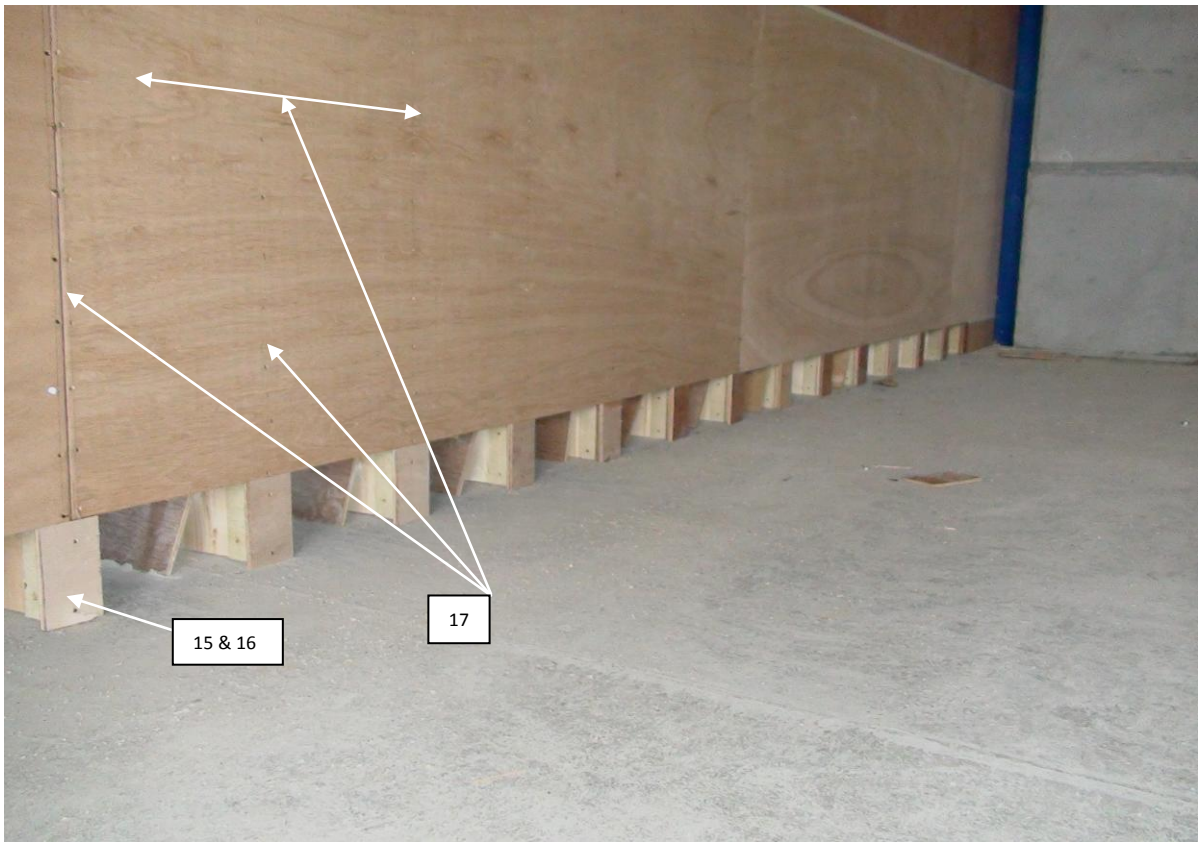

Fig 2

Main Air Duct Parts List

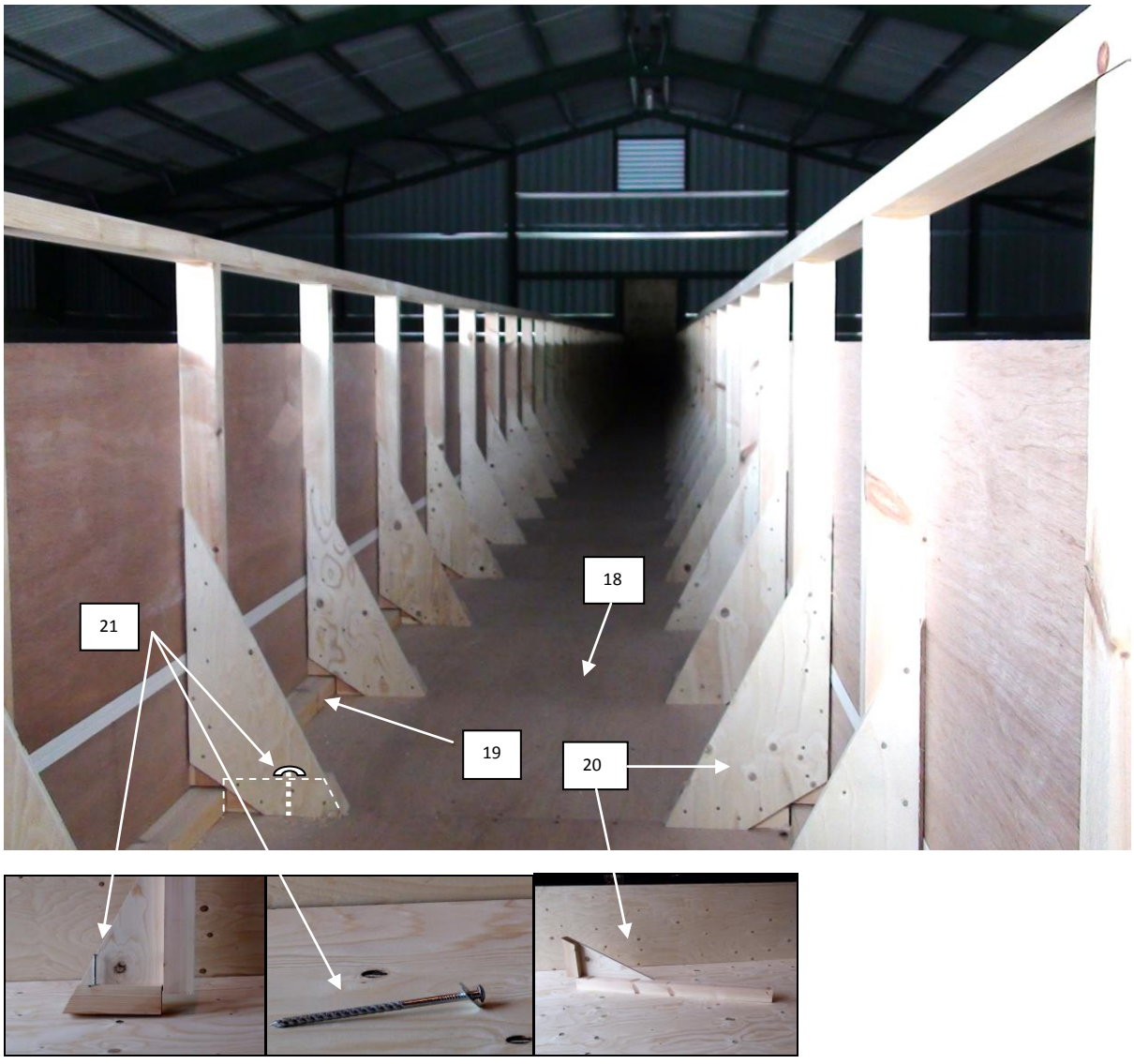

Fig 3

Main Air Duct Walkway

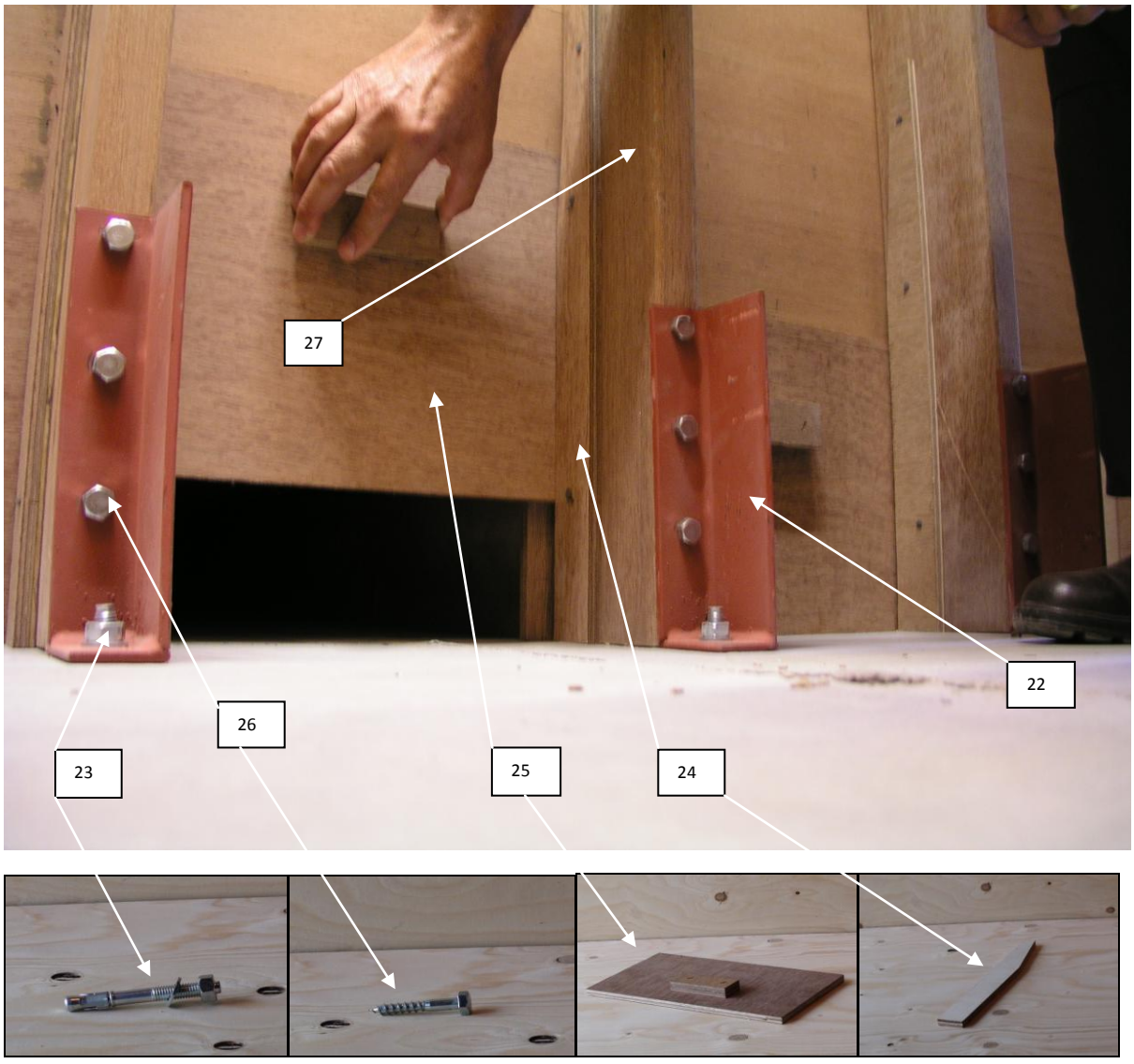

Fig 4

Main Air Duct Internal Fittings

Fig 5

Main Air Duct Construction

Fig 6

Side Main Air Duct

Install a Standard Main Air Duct

1. **Preparation** You will have received customized plans and parts lists for your self-installation project with the delivery of the materials. Read the plans and parts list carefully before you start. Check all materials are present and that no damage has occurred in transit. Clear the work area of all debris and any materials not required for the installation task. All parts are identified in the guide by an item number – this number is shown in brackets after each item specified in the text.
2. **Installing a Central Main Air Duct**
3. Mark the floor to show the line of the two sides of the duct.
4. Place the duct parts on the floor close to the work area such that the duct frames (27) are nearest to the duct line and with sufficient room allowed around the plywood for the marking operation.
5. Mark the plywood sheets (3) at the frame (27) spacing (812 mm for 18 mm ply or 406 mm for 12 mm ply) with 1220 mm long lines. The nail (17) spacing along these lines is 100 mm starting 50 mm from one edge.
6. Fit the ply end plates (1) to the duct end frames (frames with gussets one side only) sealing the joint with mastic and fixing with 45 mm nails (17) at 100 mm spacing. Fit a 70 mm x 45 mm sealing noggin (6) along the bottom edge between the frame's legs with the 45 mm face fixed to the plywood. Stand up the blank end frame and secure firmly in an upright position.
7. Using mastic at all joints, nail the first plywood roof sheet to the end frame then secure the next frame to the roof sheet in an upright position. Continue to the other end of the duct.
8. Mastic along both edges of the roof sheets and fit the sealing stringer (6) along both sides with 75 or 90 mm (28) nails into the frames from above and 45 mm nails (17) through the plywood at 100 mm spacing from below. Ensure that all frames pull up tight to the stringer.
9. Fix outlet squares (15) and extended outlet squares (16) to the duct frames. Put a double bead of mastic on each frame where a ply joint occurs and on the face of the stringer.
10. Fix the bottom row of plywood sheets at each end to the joining frames and locate the intermediate frames in the correct position using locally made up spacer blocks (for 18 mm ply on hardwood frames cut the spacer

block to 771 mm or to 767 mm for softwood frames. For 12 mm ply on hardwood frames cut the spacer block to 365 mm or to 361 mm for softwood frames. Fit a mastic filled joining strip (2) onto the top of the plywood.

11. If the concrete floor is not level trim the outlet squares to ensure that the ply sheets run in line with each other **and do not lift off the top line of the outlet squares**.
12. For 12 mm ply fit mastic filled joining strip (2) onto the top of the ply; for 18 mm ply use a horizontal row of mastic sealed timber noggins between the frames to join the rows of sheets.
13. Nail up the plywood with 45 mm nails (17).
14. Fit slide guides (24) with a 4 mm tolerance, i.e. for 12 mm slides allow a 16 mm gap.
15. Fit the anchor brackets (22) to the frame legs (27) with three coach screws (26) into 8 mm drilled holes for hardwood or 6 mm holes in softwood frames.
16. Fix both end-frames down in the correct positions with expansion bolts (23), use a string line to ensure the remaining frames are fixed in the correct position and secure with expansion bolts (23).
17. Fit handrail supports (4) to the plywood joint-frames (13) ensuring that these are vertical to the duct and alternate the frames with drive screws (21) and washers into 6 mm drilled holes.
18. Cut the handrail to join on the handrail support (6) and fit with 75/90 mm nails (28). Plane the two top edges to 45 degrees and ensure that the edges are smooth.
19. Fit the access door (7), ladder (11), ladder fixing brackets (12) and 50 mm x 50 mm duct corner flashings (10). Fit the ladder hand grabs 13) with the upper attachment brackets at the top of the plywood section of the access walkway (recommended height).
20. If timber floors are to be installed, fit the rubbing timber (14) sealing jointing surfaces to duct and floor with mastic and nailing from inside the duct through the plywood into both the arris rail and the first floor board at 100 mm spacing.

21. Place the slides (25) into the guides and check that they all operate smoothly.
22. Fit the next row up of plywood sheets to each side nailing into each frame and into the sealing stringer (19) at 100 mm spacing.
23. Fit a second run of joining strip (this does not need mastic if it is above the stringer) and the top row of ply sheets
24. Once the duct has been fully clad, run a bead of mastic over each vertical sheet joint and fit the cover strips to squeeze this in.
25. Complete a final check of the duct ensuring that all nail heads are flush or sunk just below the level of plywood sheets/flashings and that all walkway nails are fully embedded. Clean the finished duct of all residual debris and allow the sealants to dry for 24 hours before running the fans or loading crops or cereals.

Install a 3.66m Softwood Main Air Duct

26. **Preparation** You will have received customized plans and parts lists for your self-installation project with the delivery of the materials. Read the plans and parts list carefully before you start. Check all materials are present and that no damage has occurred in transit. Clear the work area of all debris and any materials not required for the installation task. All parts are identified in the guide by an item number – this number is shown in brackets after each item specified in the text.

27. **Installing a 3.66m Softwood Main Air Duct**

28. Mark the floor to show the line of the two sides of the duct.

29. Place the duct parts on the floor close to the work area such that the duct frames (27) are nearest to the duct line and with sufficient room allowed around the plywood for the marking operation.

30. Mark the plywood sheets (3) at the frame (27) spacing at 406 mm with 1220 mm long lines. The nail (17) spacing along these lines is 100 mm starting 50 mm from one edge.

31. Fit the ply end plates (1) to the duct end frames (frames with gussets one side only) sealing the timber frame to ply joints with mastic applied using a nozzle and fixing with 45 mm nails (17) at 100 mm spacing. Fit a 70 mm x 45 mm sealing noggin (6) along the bottom edge between the frame's legs with the 45 mm face fixed to the plywood. Stand up the blank end frame and secure firmly in an upright position.

32. Apply adhesive with a nozzle and spreader or roller at **all** timber frame to ply joints, nail the first plywood roof sheet to the end frame then secure the next joint frame to the roof sheet in an upright position. Continue to the other end of the duct applying adhesive to all timber joint frames and roof sheet joints and nail each sheet in position before the adhesive dries.

33. Apply mastic along both edges of the roof sheets and nail the sealing stringer (6) along both sides with 75 or 90 mm (28) nails into the frames from above and 45 mm nails (17) through the plywood at 100 mm spacing from below. Ensure that all frames pull up tight to the stringer.

34. Temporarily fix the supplied spacer strips of ply to the frame legs (same height as the outlet squares) to correctly space the frame legs. Locate the intermediate frames in the correct position using locally made up spacer

blocks to 361mm. **Note:** adjust the height of the spacer strip as required to give the correct line and height along the duct if the concrete floor is not perfectly flat. If the concrete floor is not level trim the outlet squares to ensure that the ply sheets run in line with each other **and do not lift off the top line of the temporary spacer strips.**

35. Now fix the bottom row of plywood sheets. Apply adhesive to all bottom row timber frame to ply joints and nail up the plywood with 45 mm nails (17) before the adhesive dries. Remove the spacer strips and fix outlet squares (15) and extended outlet squares (16) to the duct frames.
36. Fit a mastic filled joining strip (2) onto the top of the bottom row of plywood sheets.
37. Fit slide guides (24) with a 4 mm tolerance, i.e. for 12 mm slides allow a 16 mm gap.
38. Fit the anchor brackets (22) to the frame legs (27) with three coach screws (26) into 6 mm holes.
39. Fix both end-frames down in the correct positions with expansion bolts (23), use a string line to ensure the remaining frames are fixed in the correct position and secure with expansion bolts (23).
40. Fit handrail supports (4) to the plywood joint-frames (13) and every other frame (i.e. 813mm centres) ensuring that these are vertical to the duct and in line with the frames with drive screws (21) and washers into 6 mm drilled holes.
41. Cut the handrail to join on the handrail support (6) and fit with 75/90 mm nails (28). Plane the two top edges to 45 degrees and ensure that the edges are smooth.
42. Fit the access door (7), ladder (11), ladder fixing brackets (12) and 50 mm x 50 mm duct corner flashings (10). Fit the ladder hand grabs 13) with the upper attachment brackets at the top of the plywood section of the access walkway (recommended height).
43. If timber floors are to be installed now is the time to install them. Once installed fit the rubbing timber (14) and seal the jointing surfaces to the duct and the floor with mastic and nail from inside the duct through the plywood into the arris rail at 100 mm spacing.

44. Now continue with the duct and place the slides (25) into the guides and check that they all operate smoothly.
45. Put a double bead of mastic on the face of the walkway stringers and fit the next row up of plywood sheets to each side applying adhesive to timber frame to ply joints and nailing into each frame and into the sealing stringer (19) at 100 mm spacing.
46. Fit the middle and top row of plywood sheets using adhesive and nails as described previously.
47. Fit a second run of mastic-filled joining strip between the middle and the top row of ply sheets.
48. Once the duct has been fully clad, run a bead of mastic over each vertical sheet joint and fit the cover strips to squeeze this in.
49. Complete a final check of the duct ensuring that all nail heads are flush or sunk just below the level of plywood sheets/flashings and that all walkway nails are fully embedded. Clean the finished duct of all residual debris and allow the sealants to dry for 24 hours before running the fans or loading crops or cereals.

Installing a Side Main Air Duct

1. **Preparation** You will have received customized plans and parts lists for your self-installation project with the delivery of the materials. Read the plans and parts list carefully before you start. Check all materials are present and that no damage has occurred in transit. Clear the work area of all debris and any materials not required for the main air duct installation task. All parts are identified in the guide by an item number – this number is shown in brackets after each item specified in the text.

2. **Installation**

3. Mark the floor with a chalk line to locate the rear face of the back plywood wall of the duct 12 mm out from the duct frame (27); this chalk line is to be at least 70 mm away from any obstructions along the wall of the building.

4. Mark the floor with a second chalk line to locate the front line of the duct frames.

5. Place the parts on the floor close to the work area such that the frames are nearest to the duct line and that sufficient room is allowed around the plywood for the marking operation.

6. Mark the plywood sheets (3) at the frame spacing (406/813 mm for 1220 mm hardwood top boards) with 1220 mm long lines. The nail spacing along these lines is 100 mm starting 50 mm from one edge.

7. Fix a 50 mm x 50 mm softwood rail (28) to the back face of the rear chalk line with frame fixers (29) at nominal 1.2 m spacing. Apply mastic between the timber and the concrete to fully seal this rail to the rear ply wall of the duct.

8. **Rear Access Restricted.** If access to the back of an installed duct is restricted then the walkway and rear plywood sheets must be fitted with the duct being initially constructed approximately 600 mm out from its final position. Once the walkway and rear plywood sheets have been fitted apply a bead of mastic to the front face of the softwood rail and then move the duct into its final position.

9. **Rear Access Available.** If access to the back of an installed duct is available the softwood rail can be fitted once the duct is clad avoiding step 7.

10. Fit the ply end plates (1) to the duct end frames (frames with gussets one side only) sealing with mastic and fixing with 45 mm nails at 100 mm spacing. Fit a 70 mm x 45 mm sealing noggin (6) along the bottom edge between the frame's legs with the 45 mm face fixed to the ply.
11. Stand up blank end frames and temporarily secure firmly in an upright position. Using mastic at all joints, nail first roof sheet to the end frame then secure next frame to the roof sheet in an upright position. Continue to the other end of the duct.
12. Mastic along both edges of the roof sheets and fit the sealing stringer (19) along both sides with 75 or 90 mm nails into the frames from above, and 45 mm nails through the ply at 100 mm spacing from below. Ensure all frames pull up tight to the stringer. Put a double bead of mastic on each frame where a ply joint will occur and on the face of the stringer.
13. Fix the bottom row of rear plywood sheets to the joining frames and locate the intermediate frames in the correct position using spacer blocks. Fit a mastic filled joining strip (2) onto the top of the rear ply. Fit the top row of rear sheets, nail into the frames and the sealing stringer to the walkway. Place the rear bottom sheets with a 5 mm gap to the concrete to facilitate moving the duct back without the ply fouling on the concrete.
14. Once the walkway and rear ply is fitted push the duct back into its final position and nail the rear plywood to the softwood rail with 45 mm nails at 100 mm spacing. Nail up the plywood with 45 mm nails.
15. Fix outlet squares and extended outlet squares to the front of the duct frames.
16. Fix the bottom row of front ply sheets to the joining frames and locate the intermediate frames using the spacer blocks. **Note:** If using 18 mm ply fit sealing blocks with mastic onto the top of the front ply; if using 12 mm ply then use joining strip (2).
17. Fit slide guides (24) with a 4 mm tolerance, i.e. for 12 mm slides allow a 16 mm gap.
18. Fit the anchor brackets (22) to the **front** legs with three coach screws (26) into 8 mm drilled holes for hardwood frames or 6 mm if using softwood frames. Fix both end frames down in the correct positions with expansion bolts (23), use a string line to ensure the remaining frames are fixed in the

correct position. Secure with expansion bolts through the anchor brackets and frame fixers (29) through the base sealing timber.

19. Fit handrail supports (4) on the front of the duct to ply joint frames and alternate frames (frames 1, 3,4,6,8,9,11, etc.) with drive screws & washers into 6 mm drilled holes.
20. Fit next row up of ply sheets to front side, nailing into each frame and the sealing stringer at 100 mm spacing.
21. Fit handrail onto supports with 75/90 mm nails. Plane the two top edges to 45 degrees.
22. Fit cover strips over vertical joins of side ply sheets.
23. Fit the access door (7), ladder (11), ladder fixing brackets (12) and 50 mm x 50 mm duct corner flashings (10). Fit the ladder hand grabs (13) with the upper attachment brackets at the top of the plywood section of the access walkway.
24. If timber floors are to be installed, fit the arris rail (14) nailing with a nail gun from inside the duct through the plywood into both the arris rail and the first floor board at 100 mm spacing.
25. Place the slides (25) into the guides (24) and check that they all operate smoothly.
26. Complete a final check of the duct ensuring that all nail heads are flush or sunk just below the level of plywood sheets/flashings and that all walkway nails are fully embedded. Clean the finished duct of all residual debris and allow the sealants to dry for 24 hours before running the fans or loading crops or cereals.