'ARC' Continuous

RADIANT TUBE
HEATING SYSTEM

TECHNICAL MANUAL - VOLUME 1

ENGINEERING / DESIGN

LLOYD'S REGISTER QUALITY COMPANY ISO9002

CERTIFIED TM

DESIGN CERTIFIED TM

AMBIRAD®
ENERGY EFFICIENT HEATING SYSTEMS

'ARC' SERIES CONTINUOUS RADIANT TUBE HEATING SYSTEM

SECTION INDEX

CONTENTS:

'ARC' SERIES CONTINUOUS RADIANT TUBE HEATING SYSTEM

GENERAL SPECIFICATION EQUIPMENT SPECIFICATION

CONTENTS:

The Ambi-Rad ARC Series direct gas fired radiant heating system consists of one or more vacuum fans each of which operates a sub system of in line gas burners, located in series at varying intervals in one or more 4 in. dia. tubes. The radiant heat emitted from the hot tube is directed downwards by reflectors.

The tube into which the burners are mounted and over which the reflectors are fitted and emits the maximum heat is called the radiant tube. The remaining interconnecting tube is called the tail pipe and radiates with less intensity. The operating temperatures of the tubes generally range from 140°F – 900°F max.

The purpose of the vacuum fan is three fold; to create a high negative pressure within the radiant tube and tail pipe so as to discharge the spent products of combustion from the system to a point outside the building being heated; to control the flow of gas and air through each burner in stoichiometric proportions; to draw carrier air into the tube system at the start of each radiant branch, in order to distribute the heat from the flame along the tube.

The slimline burner head of the ARC Series system prevents flame disturbance by the carrier air which results in a quieter burner, and most importantly emissions of NOx and CO considerably below the most stringent World regulations.

The ARC Series System as a result of the stoichiometric fuel/air mixture at the burner head together with the negative pressure zero governor provides optimum combustion conditions at all times independent of fluctuations in fuel pressure, atmospheric pressure, wind velocity or other climactic disturbances.

System efficiency of over 90% can be achieved, and good distribution of heat along the radiant tube can thus be maintained.

EQUIPMENT SPECIFICATION

1 BURNER

Each burner will consist of:–

A Burner Control Housing (BCH), of chassis style with detachable pivoting lid. All control wiring to the burner head is within the BCH, which also contains a combination gas valve, dedicated zero governor and filter, a full sequence controller and cassette air filter for primary air supply to the burner. Externally on the BCH, neon lights indicate MAINS ON and BURNER ON modes.

A burner head assembly of lightweight cast aluminum construction, a ceramic style burner head insert, maintained in position by the flame retention grid. The casting assembly also accommodates the gas jet, air shutter and mixing chamber. The ignition and flame sensing electrode assembly is mounted to the casting flange forward of the burner face.

The unique feature of the ARC Series burner head is the aerodynamic shape which reduces the pressure drop across the burner head and also promotes a greater volume of flame at the bottom of the tube, where maximum release of heat is desirable.

A Combustion Chamber as a continuation of the radiant tube with an external rectangular turret for connection of the burner assembly.

A support point is provided forward of the external turret.

2 SYSTEM TUBES

RADIANT TUBES

The tube shall be black mild steel, aluminized steel or schedule 40 iron pipe. The tube/fittings are connected together utilizing special stainless steel wrap around couplings. Schedule 40 iron pipe shall be coupled together with threaded steel couplings or welded.

TAIL PIPE

The tail pipe section lengths to be determined by the total system flow units. Tail pipes will be either 4 in. or 6 in. dia. Construction material will range from aluminized steel, stainless steel, pure grade aluminum or mild steel with a corrosion resistant coating, or schedule 40 iron pipe.

3 COMBUSTION

The air and gas are pre-mixed to stoichiometric proportions within the burner head assembly, prior to being admitted to the point of combustion.

4 IGNITION

Ignition is by an electric arc forward of the face of the burner head on to the main frame.

5 END VENT MODULE (EVM)

At the start of each radiant branch an End Vent Module is connected to the rear of the first combustion chamber.

6 COMBUSTION AIR

This is normally taken from within the areas being heated, but if necessary because of dust/dirt or chemicals in the internal environment, ducted Air Adapters can be fitted to the Burner Control Housing and/or End Vent Modules.

7 VACUUM FANS

A low noise robust stainless steel fabricated centrifugal fan with aluminum impeller or aluminum fan housing with aluminum impeller capable of a static pressure of either 5.5 in w.c or 7.5 in. w.c at 68°F and directly coupled to a totally enclosed motor to be fitted at the end of the tube system. The fan exhausts the products of combustion from the system discharging through an outlet flue pipe to atmosphere external to the building. The maximum operating temperature is 400°F.

8 REFLECTORS

The radiant tube sections of the system are fitted with reflectors made of either Stainless Steel, Aluminum or Alumasteel to direct infra-red rays downwards. The reflectors have a unique design profile to maximize the reflected radiant heat, minimize convective loss, and maintain rigidity. The reflectors are overlapped and held in position by the reflector bracket assembly.

9 CONDENSATION

Due to the high efficiency of the system, condensation can form during the operating cycle of the system. Condensate traps are provided at the inlet to each vacuum fan.

Material specification for drain must be resistant against the action of flue gas condensate and suitable for operation up to a maximum temperature of 180°F.

10 ELECTRICAL

The burners are suitable for operation on 120v single phase 60Hz supply and the vacuum fans are available for either 120v single phase 60Hz supply.

11 CONTROLS

The system may be controlled with conventional line voltage or low voltage thermostats with suitable transformers and relays or with an AMBI-RAD control panel and with optional black bulb sensor.

12 TESTING & BALANCING

System start-up shall be in accordance with manufacturers instructions.

13 APPROVALS

The ARC system is AGA certified to comply to ANSI STANDARD Z83.6 and CAN 1-2.16. CSA INTERNATIONAL 1178754 (FBR111910).

TECHNICAL INFORMATION

BURNER MODEL	ARC12LR	ARC18LR	ARC24LR	ARC32LR	ARC38LR	ARC46LR
HEAT INPUT Btu/h	41,000	61,000	82,000	109,000	130,000	157,000
GAS CONSUMPTION						
Nat. Gas ft^3/h	40.5	60.8	81.1	106.4	126.4	153.0
Propane ft^3/h	16.4	24.6	32.8	43.0	51.1	61.8
INLET GAS PRESSURE in w.c.						
Max.	12	12	12	12	12	12
Min.	4.8	4.8	4.8	4.8	4.8	4.8
RADIANT TUBE LENGTH (DIST. BETWEEN BURNERS) ft						
Min.	17	24	31	46	59	75
Max.	24	34	43	59	75	88

BURNER MODEL ELECTRICAL DETAILS	ARC12LR	ARC18LR	ARC24LR	ARC32LR	ARC38LR	ARC46LR
Volts	120	120	120	120	120	120
Phase	1	1	1	1	1	1
Amps	0.1	0.1	0.1	0.1	0.1	0.1
Hz	60	60	60	60	60	60

WEIGHT OF SYSTEM	
ARC LR Burner (12, 18, 24, 32, 38, 46)	14.2lb.
Radiant Branch (without burner or ducted air)	5.6lb/ft
Radiant Branch + Slimline 'M' decorative grille	7.3lb/ft
Radiant Branch + Protective Guards (without burner or ducted air)	6.7lb/ft
Tail pipe	Various
Max. weight per suspension point at end vent position (less ducted air, chain and grilles)	55lb.

NOTE: All supporting chain excluded from above

BURNER MODEL	ARC12LR	ARC18LR	ARC24LR	ARC32LR	ARC38LR	ARC46LR
DISTANCE FROM COMBUSTIBLES in.						
Below Tube	End Vent/In-line	End Vent/In-line	End Vent/In-line	End Vent/In-line	End Vent/In-Line	End Vent/In-line
Without Undershield	44/50	44/50	44/50	56/67	63/83	67/83
With Undershield	30/34	30/34	30/34	30/34	31/41	34/41
Above Tube	4	4	4	4	4	4
Horizontally						
Standard Reflector	20	20	28	28/34	28/39	28/39
Perimeter Reflector	12/18	12/18	12/18	12/20	12/24	12/24

⚠ WARNING

FIRE OR EXPLOSION HAZARD

Clearance to combustibles must be maintained in all situations. Failure to maintain clearances to combustibles could result in a serious fire hazard, injury or death. Minimum clearances must be maintained from vehicles, aircraft and all items below the system.

In locations used for the storage of combustible materials, signs shall be posted to specify the maximum permissible stacking height in order to maintain required clearances from the heater to the combustibles. In addition the manufacturer recommends posting these signs adjacent to the heater thermostats for enhanced visibility.

BURNER NOISE DATA

BURNER MODEL	ARC12LR	ARC18LR	ARC24LR	ARC32LR	ARC38LR	ARC46LR
NOISE LEVEL AT 10 ft. BELOW BURNER						
dB(A)	46	47	47	48	50	51
NR ±2	40	41	41	42	44	45

END VENT MODULE NOISE DATA

EVM TYPE	NOISE LEVEL AT 10 ft., BELOW EVM		NOISE LEVEL AT 10 ft. BELOW EVM (WITH SILENCER)	
	dB (A)	NR ±2	dB (A)	NR ±2
12	46	40	44	38
18	48	42	45	39
24	48	42	45	39
32	52	46	48	42
38	55	49	51	45
46	58	52	53	47

VACUUM FAN NOISE DATA

FAN TYPE	FAN DUCTED IN & OUT				FLUE HORIZONTAL / VERTICAL			
	NOISE LEVEL AT 10ft BELOW FAN		NOISE LEVEL AT 10ft BELOW FAN IN ACOUSTIC ENCLOSURE		NOISE LEVEL AT 10ft		NOISE LEVEL AT 10ftWITH EXHAUST SILENCER	
	dB (A)	NR ±2	dB (A)	NR ±2	dB (A)	NR ±2	dB (A)	NR ±2
F100	64	58	53	47	72	66	59	53
F200	65	59	55	49	75	69	62	56

Note : All noise levels are as measured in site conditions which may vary for each installation.

VACUUM FAN TECH. DATA

FAN TYPE	Duty at 68°F		Max. Operating temp °F	Weight Lb	Single Phase 120V/60Hz		
	Flow Units	Pressure in w.c			Power HP	FLC Amps	Starting Current Amps
F100	100	5.5	400	27	0.50	5.5	28
F200	200	7.5	400	77	1.0	11.5	55

2

'ARC' SERIES CONTINUOUS RADIANT TUBE HEATING SYSTEM

SYSTEM DESIGN

CONTENTS:

INTRODUCTION

The ARC Series comprises a continuous system with a number of burners located in series in a radiant branch, and a number of radiant branches manifolded together, linked by a tail pipe to a vacuum fan discharging the spent products of combustion to atmosphere.

A system may consist of just one burner and one vacuum fan, to multiple burners in multiple radiant branches with one or more vacuum fans.

To enable exact matching of operational needs within an area, distances between burners and ratings of the burners can vary.

The unique feature of the ARC Series is a radiant system which provides uniform heat coverage of the floor area, eliminating hot/cold spots.

BEFORE THE LAYOUT OF THE 'ARC' SYSTEM CAN BE PLANNED, THE FOLLOWING INFORMATION IS REQUIRED:–

1 SITE INFORMATION

1.1 Use of building.

1.2 Internal environmental temperature required.

1.3 External minimum air temperature.

1.4 Size and details of building.

- a. Type of walls, roof construction and insulation.
- b. Floor construction and insulation.
- c. Window sizes and positions.
- d. Location, size, type and construction of doors.
- e. Ceiling height.
- f. Clearance required from floor.
- g. Location of any cranes, crane rails and clearance required.
- h. Location of any sprinkler system and lighting fittings.
- i. Check that sufficient clearances to combustible materials can be maintained.

1.5 Air changes per hour.

1.6 Frequency and length of time any large doors are opened.

1.7 Type and pressure of gas and meter location.

1.8 Details of electrical supply.

1.9 Presence of air-borne contaminents, dust, paint-spray, corrosive vapours etc,

The above information is best obtained by site survey by a qualified engineer and will be the basis of the heat loss calculations required for the determination of the layout of the ARC System based on the A.S.H.R.A.E. Guide.

2 SYSTEM CAPACITY

2.1 Calculate the building heat losses using methods set out in the current A.S.H.R.A.E. Guide for radiant heating.

Heat loss of building .... A.Btu/hr

Mounting height correction factor ...... X%

(The mounting height correction factor is determined by multiplying the system height in excess of 16ft by 1% per ft).

$$\text{'ARC' System Capacity Required} = \frac{A + X\%}{0.90 \text{ (efficiency)}}$$

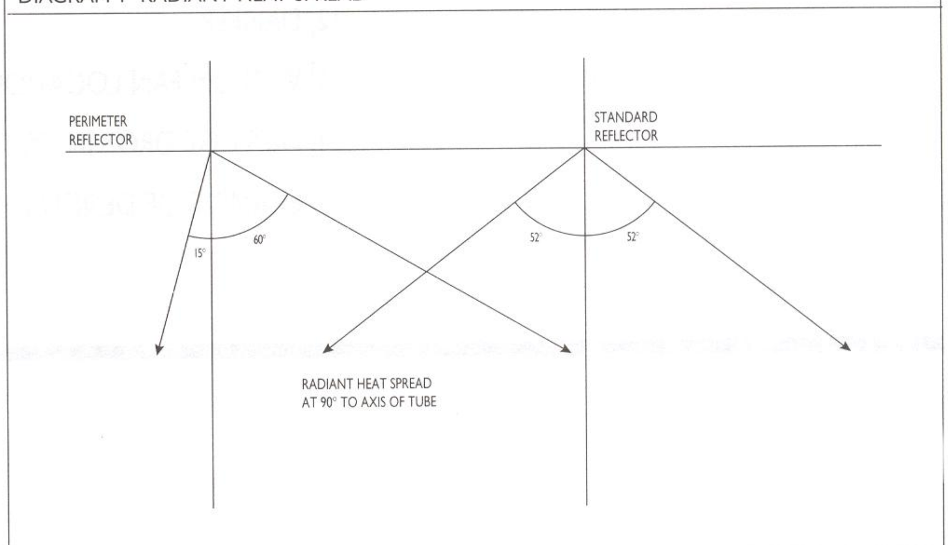
3 POSITION OF RADIANT TUBE

The position of the radiant branch with burners i.e. maximum radiant heat emission, should be determined to give the required radiant heat distribution within the building.

The following must be taken into account:–

- a. The angle of radiant heat distribution from the ARC reflectors. (see diagram 1).
- b. The intersection of the angular heat spread between tubes to be approx. 6 ft. for old buildings and 2 ft. above floor level for new buildings.
- c. Mounting height.
- d. Clearance from combustibles.
- e. Lighting considerations.
- f. Zone control requirements.
- g. Sprinkler positions.

DIAGRAM 1 RADIANT HEAT SPREAD



4 BURNER SELECTION

The burner input sizes are determined by taking into account:–

a. Mounting height.

b. Length of radiant branches.

c. Heat load per radiant branch.

d. Permissible number of burners per branch.

(See 11 DESIGN PARAMETERS)

The installed system capacity may well exceed the calculated heat losses due to layout arrangements.

5 DESIGN REQUIREMENTS FOR FLOW LOADING

The ARC burner system allows a number of burners to be fitted in series in the same radiant tube, thus enabling a long continuous radiant emitting surface to give even heat distribution within a building.
This is called the RADIANT BRANCH.
To enable the burners to be correctly sized and located within the radiant branch(s) and to terminate at the vacuum fan at the design temperature, the design layout is based upon a FLOW UNIT principal.

The FLOW UNIT is the amount of fuel/air mixture to produce a heat input of 10,000 Btu/hr. which corresponds to a flow rate of 1.83cfm at 65°–70°F.
See table 1 for total number of FLOW UNITS to be used in calculation.

For the purpose of design, FLOW UNITS are considered to enter the ARC' system at:–

1. The Burner
2. The End Vent Module

and exit the ARC System as spent products of combustion via the vacuum fan.
Each burner will have at least twice the number of FLOW UNITS passing from upstream as entering via that burner.

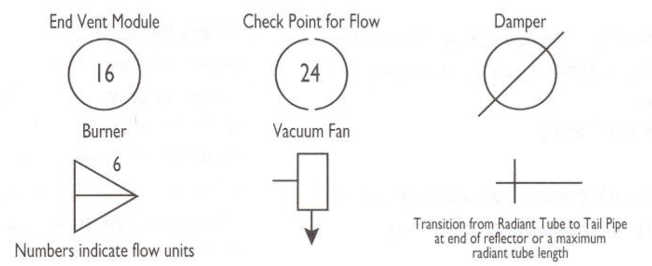
SYSTEM FLOW UNITS

TABLE 1

BURNER	BURNER FLOW UNITS	FLOW UNITS ENTERING VIA END VENT MODULE	MIN. FLOW UNITS PASSING DOWN-STREAM BURNERS
ARC 12LR	4	8	8
ARC 18LR	6	12	12
ARC 24LR	8	16	16
ARC 32LR	11	21	21
ARC 38LR	13	25	25
ARC 46LR	15	31	31

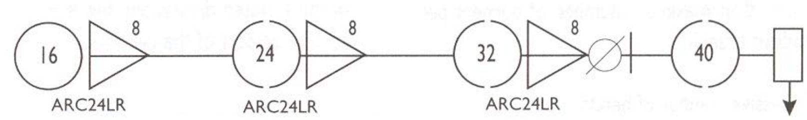
6 EXPLANATION OF SYMBOLS

DIAGRAM 2



7 RADIANT TUBE AND BURNERS

DIAGRAM 3



EXAMPLE OF CORRECT FLOW UNIT LEVEL

For the example shown above:–

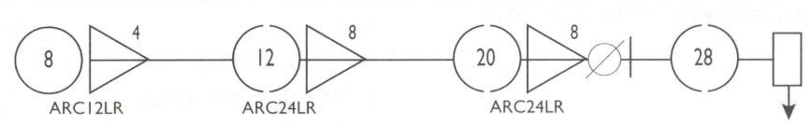
Flow Units entering EVM prior to a ARC24LR burner = 16. Flow Units entering ARC24LR = 8. Therefore total Flow Units in radiant branch at inlet to vacuum fan equals 40. [16 + (3 x 8) = 40]

(Flow Units passing each burner is at least twice the Flow Units entering via the burner).

If a radiant branch is fitted with a mixture of burner inputs, the FLOW UNITS passing each burner should be at least twice that entering via the burner.

The layout below is incorrect as there are insufficient Flow Units passing the ARC 24LR burner (second burner in line). The solution is to change the first burner to ARC18LR.

DIAGRAM 4



EXAMPLE OF INCORRECT FLOW UNIT LEVEL

8 RADIANT BRANCH CAPACITY

The capacity of a radiant branch is limited to the maximum number of burners per branch as detailed in Section 11 DESIGN PARAMETERS.

9 VACUUM CAPACITY

The correct vacuum fan must be selected to meet the total number of FLOW UNITS for the system. The fan selected must always have a capacity in excess of the total FLOW UNITS entering. There are a number of critical design requirements which if not met, will reduce the vacuum obtainable and thereby the effective capacity of the system.

These include:–

a. If sections of tail pipe have a Flow Unit loading for the length/diameter, causing excessive pressure drop.
(see diagrams 7 and 8).

b. Excessive back pressure on discharge line of vacuum fan as caused by partial blockage.

c. Air leaks in the system as caused by poor installation, missing view port windows in combustion chambers, leaky burner gaskets, poor joints, loose couplers, incorrect direction of rotation fan, or incorrectly set fan damper.

d. More than maximum number of burners per radiant branch.

e. Excessive number of bends.
(See section 10 TAIL PIPE CAPACITY)

Note:
For altitudes above 2000' reduce pump capacity 1%/1000'.

10 TAIL PIPE CAPACITY

The tail pipe is a continuation of the tube connecting the radiant branch with its burners and reflectors to the vacuum fan.

Heat is given up by the tail pipe and it is useful. to extend the use of reflectors from the Radiant Branch where practical beyond the maximum radiant tube length.

Excessive FLOW UNIT loading in a single section of the Tail Pipe will cause low vacuum, due to excessive pressure drop, resulting in poor fan capacity and reduced heat input to the building.
The tail pipe must meet the following requirements:-

a. The tail pipe length of either 4in dia. or 6in. dia. is calculated as a factor of the FLOW UNITS and radiant tube length (see diagram 5).

b. The total required length of tail pipe is to ensure the system operates at maximum efficiency and that the vacuum fan temperature is such that the fan maintains efficiency.

c. The total system pressure drop (ΔP_T) - radiant branch (ΔP_1),4in. dia. tail pipe (ΔP_2) and 6in. dia. tail pipe (ΔP_3) - must be within the pressure drop capabilities of the vacuum fan.

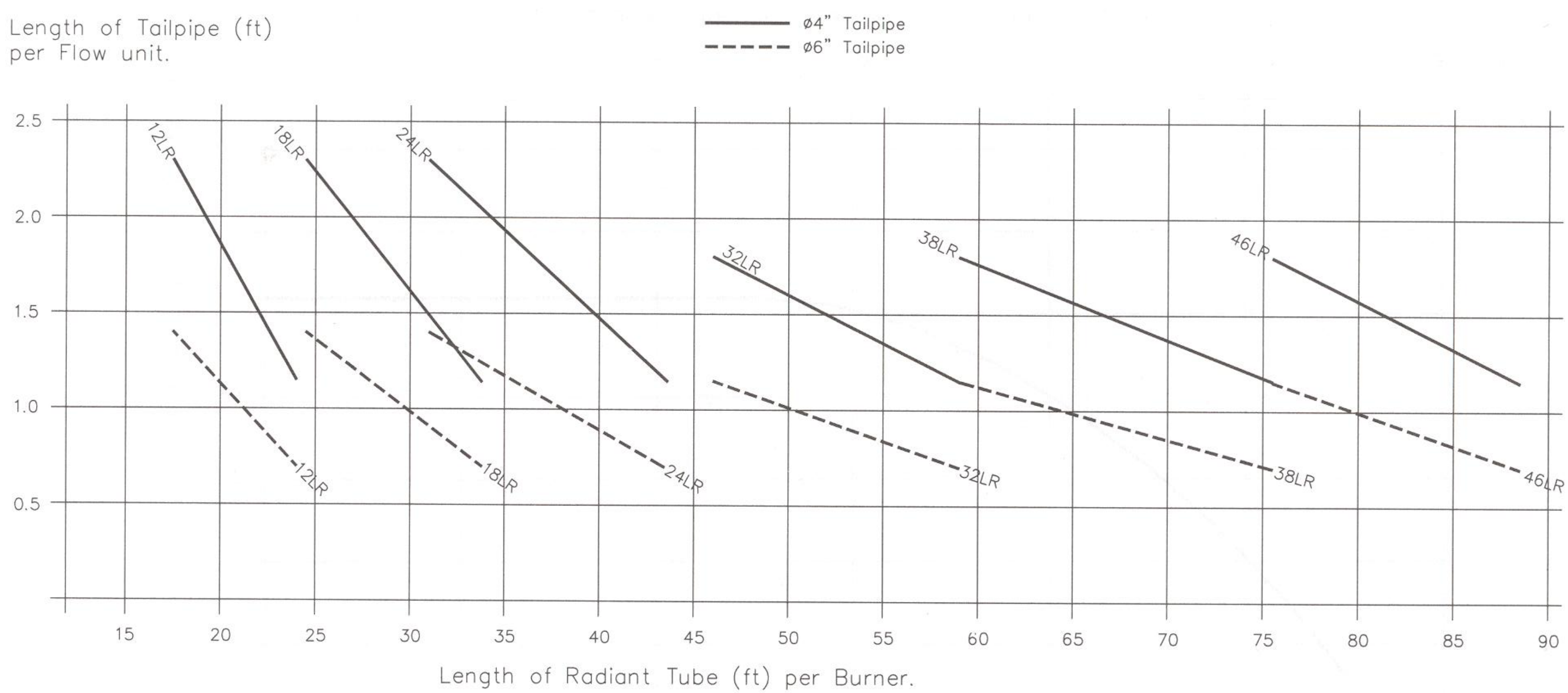
d. Where the length of 4in. dia. shared tail pipe is shown to be excessive for; FLOW UNITS to be carried, or pressure drop (ΔP_2), then either the length of tail pipe from each radiant branch should be increased and brought together closer to the vacuum fan to reduce the length of 'shared' tail pipe, or 6in. dia. tail pipe should be utilized.

11 DESIGN PARAMETERS

(1) Reflectors can be placed over the tube in excess of these stated dimensions, but it is then considered to be part of the tail pipe.

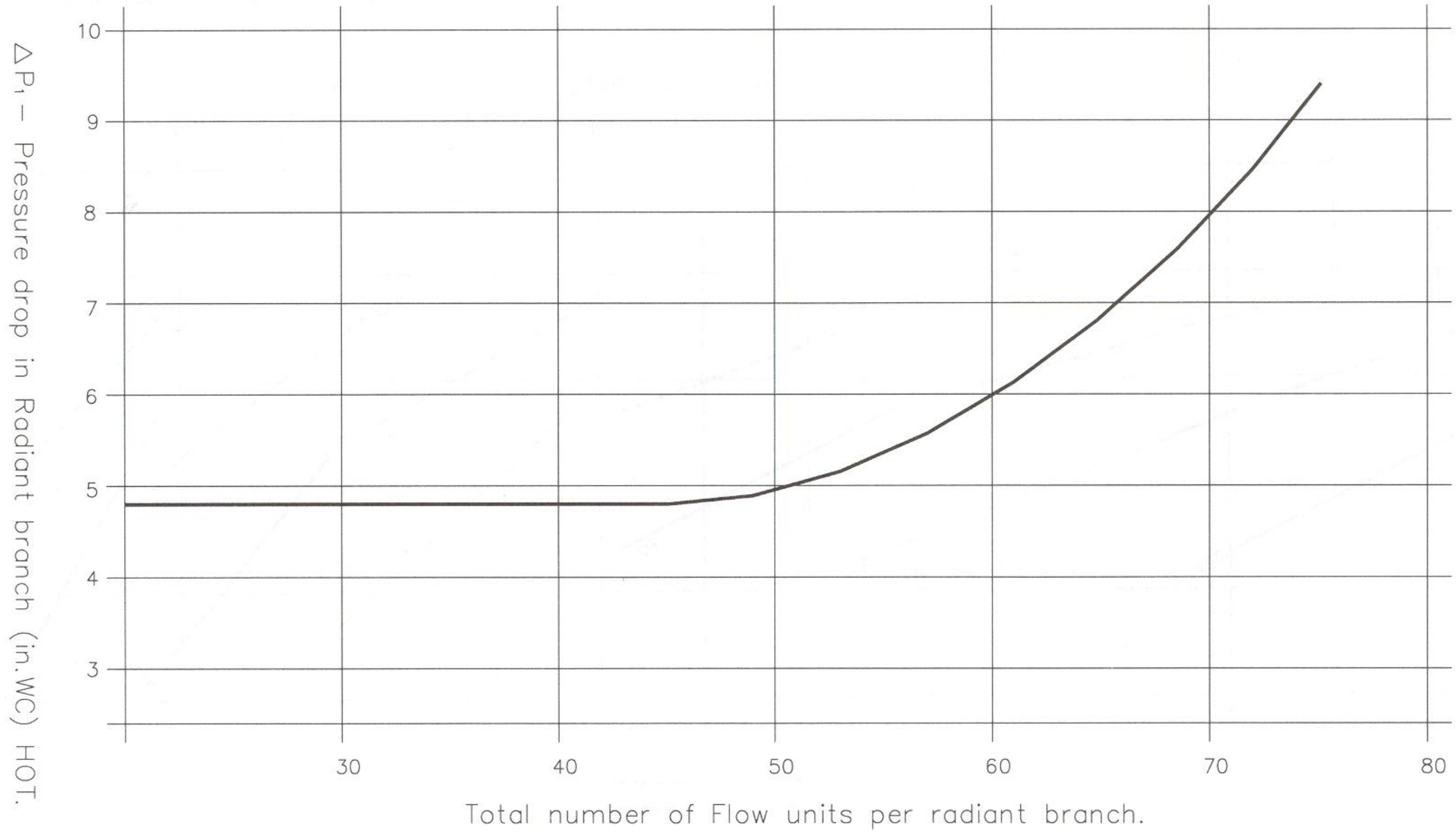
BURNER MODEL	ARC 12LR	ARC 18LR	ARC 24LR	ARC 32LR	ARC 38LR	ARC 46LR
HEATER INPUT BTU/HR	41,000	61,000	82,000	109,000	130,000	157,000
FLOW UNITS PER BURNER	4	6	8	11	13	15
FLOW UNITS PER END VENT MODULE	8	12	16	21	25	31
MAX. BURNERS PER BRANCH	5	4	3	3	3	2
RADIANT TUBE LGTH. (l) (Dist. between burners for calculating Tail Pipe length)						
MIN.	17ft	24ft	31ft	46ft	59ft	75ft
MAX.	24ft	33ft	43ft	59ft	76ft	88ft
MIN. DISTANCE BETWEEN BURNER HEAD & FITTINGS	12ft	12ft	16ft	20ft	23ft	27ft
SUGGESTED MIN. MOUNTING HEIGHT	10ft	12ft	13ft	15ft	18ft	20ft

DIAGRAM 5. TAILPIPE LENGTH CALCULATED AS A FACTOR OF FLOW UNITS AND RADIANT TUBE LENGTH



NOTE: Use worst case in any branch and multiply by total flow units in the branch.

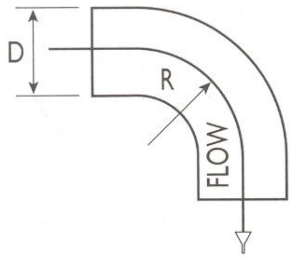
DIAGRAM 6. PRESSURE DROP ΔP_1 vs TOTAL NUMBER OF FLOW UNITS PER RADIANT BRANCH



NOTE: Each section of Radiant branch between burners contains a max. of one 90° bend.
Graph assumes maximum distance between burners.

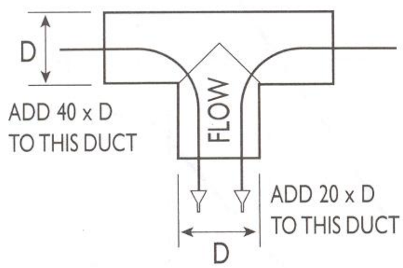
DIAGRAM 6A SUGGESTED APPROXIMATE ALLOWANCES TO BE MADE FOR FITTINGS

BENDS

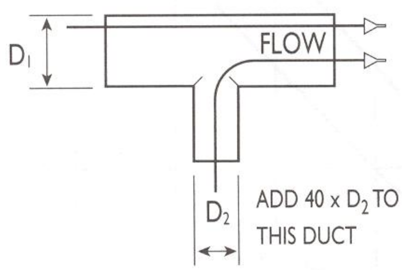


R/D approx = 1
D = diameter of duct in feet
ADD 24 x D TO DUCT LENGTH

TEES

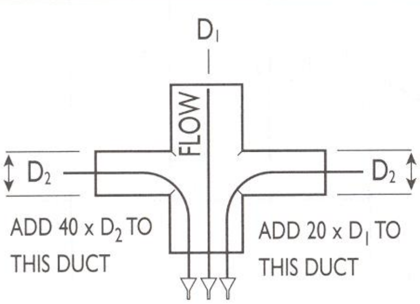


ADD 40 x D TO THIS DUCT
D = diameter of duct in feet
(FLOWS NOT NECESSARILY EQUAL)



ADD 10 x D_1 TO THIS DUCT

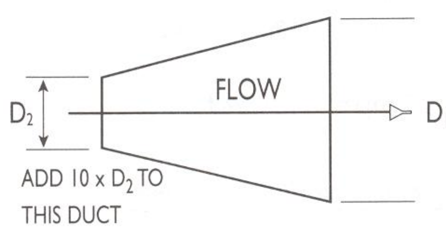
CROSSES



ADD 40 x D_2 TO THIS DUCT

D = diameter of duct in feet

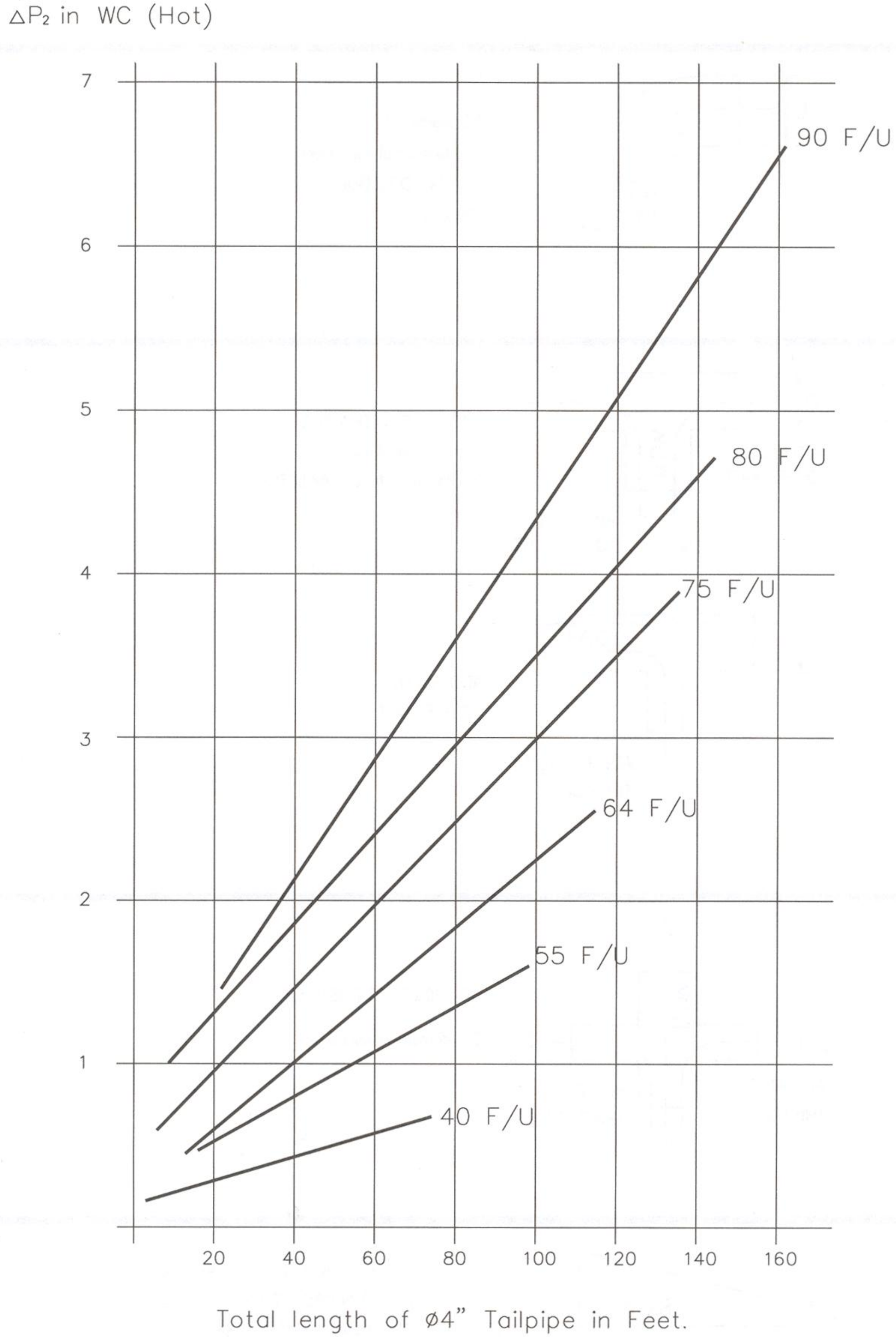
ENLARGEMENTS



THESE ALLOWANCES HAVE BEEN SIMPLIFIED IN ORDER TO APPLY TO ALL ARC HEATING SYSTEM ARRANGEMENTS LIKELY TO BE MET.

D = diameter of duct in feet

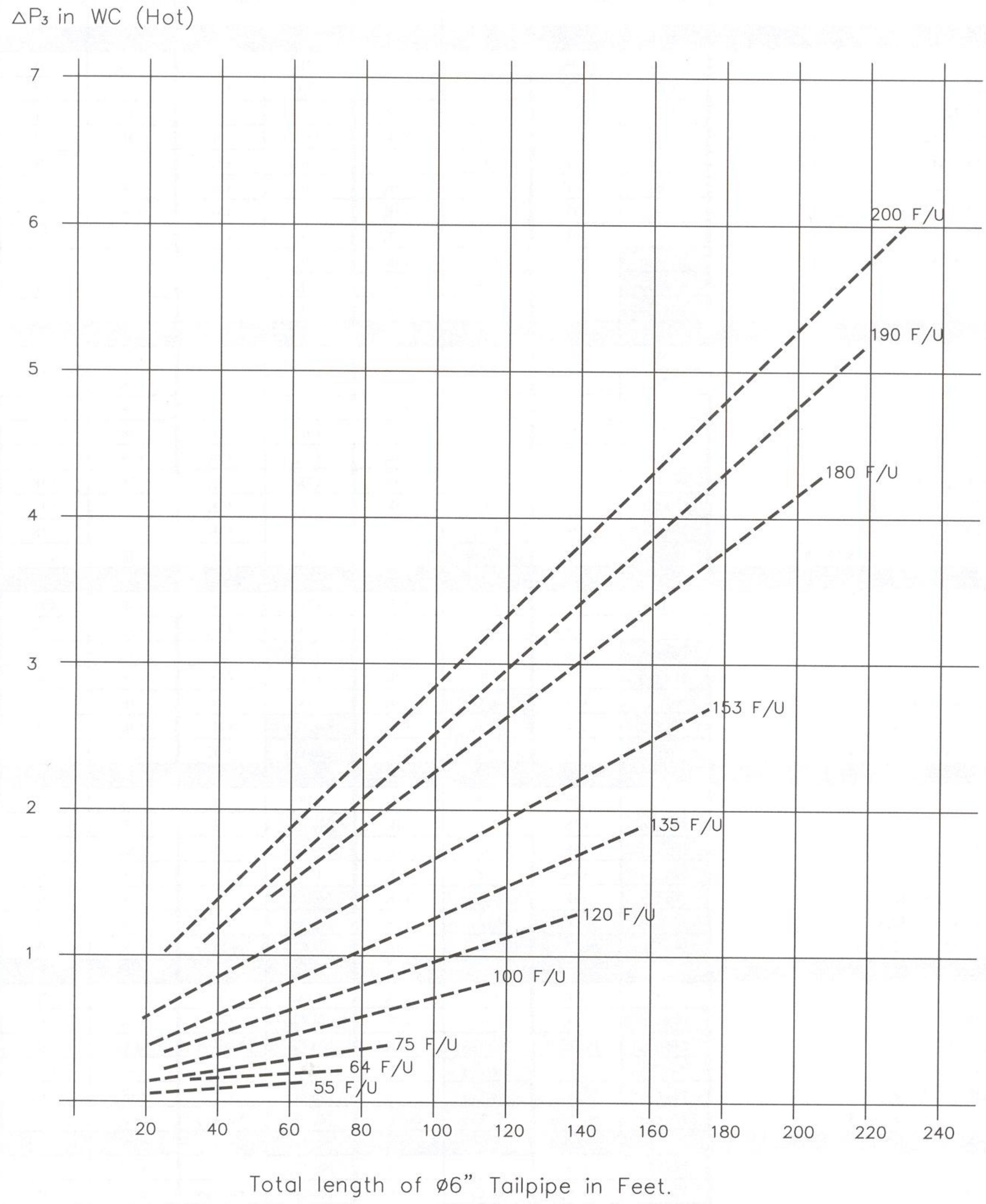
DIAGRAM 7. PRESSURE DROP (ΔP_2) vs TAILPIPE LENGTH (Ø 4") FOR VARIOUS SPECIFIED FLOW UNITS



N.B: – ΔP_2 includes 1 x Tee section & 2 x 90° bends.

DIAGRAM 8. PRESSURE DROP (ΔP_3) vs TAILPIPE LENGTH (Ø 6") FOR VARIOUS SPECIFIED FLOW UNITS

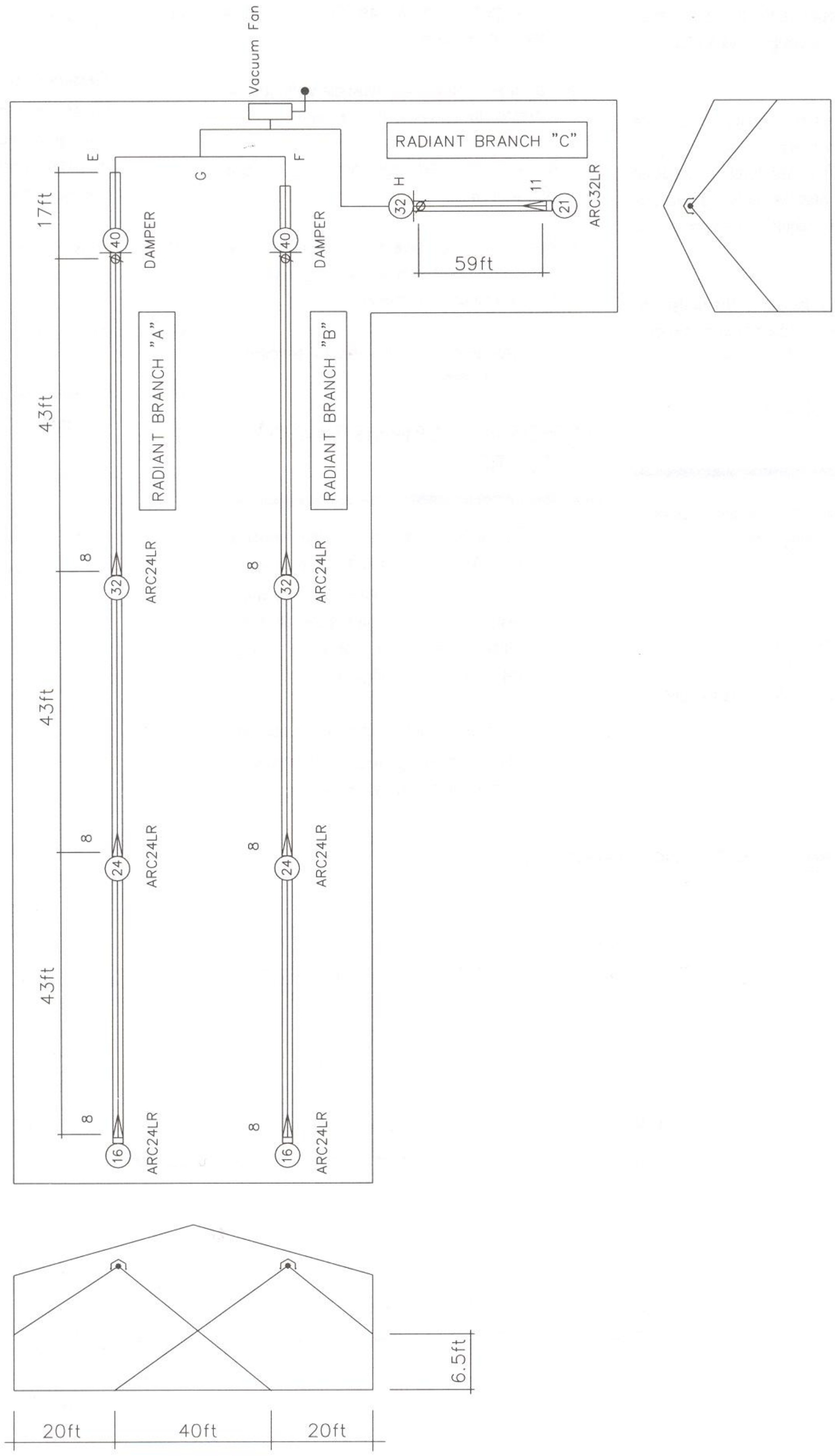
The maximum length of shared 6in. dia. tail pipe, just prior to the fan, in excess of 200 flow unit loading is 6ft.



N.B: – ΔP_3 includes 1 x Tee section & 2 x 90° bends.

	(Shared tail pipe to fan)				*(Non Shared tail pipe to fan)*			
Fan Type	**F100 100 FU**	**in. WC 5.5**	**F200 200 FU**	**in. WC 7.5**	**F100 100 FU**	**in. WC 5.5**	**F200 200 FU**	**in. WC 7.5**
Burner / Branch Combination	Tail Pipe dia.		Tail Pipe dia.		Tail Pipe dia.		Tail Pipe dia.	
	4"	6"	4"	6"	4"	6"	4"	6"
12 >	OK	OK	OK	OK	OK	OK	OK	OK
12,12 >	OK	OK	OK	OK	OK	OK	OK	OK
12,12,12 >	OK	OK	OK	OK	OK	OK	OK	OK
12,12,12,12 >	OK	OK	OK	OK	OK	OK	OK	OK
12,12,12,12,12 >	OK	OK	OK	OK	OK	OK	OK	OK
12 > < 12	OK	OK	OK	OK	OK	OK	OK	OK
12,12 > < 12,12	OK	OK	OK	OK	OK	OK	OK	OK
12,12 > < 12,12,12	OK	OK	OK	OK	OK	OK	OK	OK
12,12,12 > < 12,12,12	No Go	OK	OK	OK	OK	OK	OK	OK
12,12,12,12 > < 12,12,12,12	No Go	OK	OK	OK	OK	OK	OK	OK
12,12,12,12,12 > < 12,12,12,12,12	No Go	OK	OK	OK	OK	OK	OK	OK
18 >	OK	OK	OK	OK	OK	OK	OK	OK
18,18 >	OK	OK	OK	OK	OK	OK	OK	OK
18,18,18 >	OK	OK	OK	OK	OK	OK	OK	OK
18,18,18,18 >	OK	OK	OK	OK	OK	OK	OK	OK
18 > < 18	OK	OK	OK	OK	OK	OK	OK	OK
18,18 > < 18,18	No Go	OK	OK	OK	OK	OK	OK	OK
18,18 > < 18,18,18	No Go	OK	OK	OK	OK	OK	OK	OK
18,18,18 > < 18,18,18	No Go	OK	OK	OK	OK	OK	OK	OK
18,18,18,18 > < 18,18,18,18	No Go	OK	No Go	OK	OK	OK	OK	OK
24 >	OK	OK	OK	OK	OK	OK	OK	OK
24,24 >	OK	OK	OK	OK	OK	OK	OK	OK
24,24,24 >	No Go	OK	OK	OK	No Go	OK	OK	OK
24 > < 24	No Go	OK	OK	OK	OK	OK	OK	OK
24,24 > < 24,24	No Go	OK	No Go	OK	OK	OK	OK	OK
24,24 > < 24,24,24	No Go	OK	No Go	OK	No Go	OK	OK	OK
24,24,24 > < 24,24,24	No Go	OK	No Go	OK	No Go	OK	OK	OK
32 >	OK	OK	OK	OK	OK	OK	OK	OK
32,32 >	No Go	OK	OK	OK	No Go	OK	OK	OK
32,32,32 >	No Go	OK	OK	OK	No Go	OK	OK	OK
32 > < 32	No Go	OK	OK	OK	OK	OK	OK	OK
32,32 > < 32,32	No Go	OK	No Go	OK	No Go	OK	OK	OK
32,32 > < 32,32,32	No Go	No Go	No Go	OK	No Go	OK	OK	OK
32,32,32 > < 32,32,32	No Go	No Go	No Go	OK	No Go	No Go	OK	OK
38 >	OK	OK	OK	OK	OK	OK	OK	OK
38,38 >	No Go	OK	OK	OK	No Go	OK	OK	OK
38,38,38 >	No Go	No Go	No Go	OK	No Go	No Go	No Go	OK
38 > < 38	No Go	OK	No Go	OK	OK	OK	OK	OK
38,38 > < 38,38	No Go	No Go	No Go	OK	No Go	OK	OK	OK
38,38,38 > < 38,38,38	No Go	No Go	No Go	No Go	No Go	No Go	No Go	OK
46 >	No Go	OK	OK	OK	No Go	OK	OK	OK
46,46 >	No Go	No Go	No Go	OK	No Go	No Go	No Go	OK
46 > < 46	No Go	No Go	No Go	OK	No Go	OK	OK	OK
46,46 > < 46,46	No Go	No Go	No Go	OK	No Go	No Go	No Go	OK

DIAGRAM 9 EXAMPLE OF DESIGN LAYOUT



12 DAMPER

The vacuum fan will operate with sufficient negative pressure at its inlet to operate the burners at their correct input provided the design rules for tail pipe are followed.

The required operating negative pressure at each End Vent Module (EVM) is 2.5 in. w.c. Consult factory for installations above 2,000 ft. sea level for adjusted pressure settings. The negative pressure available may be much greater than required and vary at each EVM in the system.

It is necessary to locate a damper in the design lay-out towards the end of each radiant branch as shown in diagram 9, EXAMPLE OF DESIGN LAYOUT.

13 VACUUM FAN LOCATION AND DISCHARGE

The specific vacuum fan location and discharge details must meet the following criteria:–

a. Building Regulations.

b. Adequate tail pipe requirement.

c. Discharge away from ready access by public.

d. Meets local codes.

e. Will not give rise to complaints due to exit noise. (An exhaust silencer should be specified if noise is a potential problem).

f. Discharge must be at least 3ft from building opening or window.

g. Discharge through a combustible wall must be protected by a non-conductive sleeve.

h. Recommended discharge should be at least 18in. from wall.

i. Vertical discharge, pipe through roof must be correctly installed to avoid water ingress and to prevent against snow blockage.

j. Discharge pipe must be correctly terminated with bird screen.

14 PRESSURE DROP IN SYSTEM AND FAN SELECTION

14.1 For an ARC System the total pressure drop ΔP_T is calculated; to determine the type of vacuum fan required and to check that the tail pipe configuration does not cause excessive pressure drop, resulting in loss of efficiency.

ΔP_T must be calculated for the route (end vent to fan) giving the greatest pressure drop in the overall system layout.

Note: Pressure drop is a function of:- Flow Unit loading/pipe dia./ pipe length.

$\Delta P_T = \Delta P_1 + \Delta P_{2(a)} + \Delta P_{2(b)} + \Delta P_{3(a)} + \Delta P_{3(b)}$

ΔP_1 - Pressure drop in the radiant branch up to the damper (this is the radiant branch in the route giving the greatest pressure drop in the overall system) - (see diagram 6 & 10).

$\Delta P_{2(a)}$ - Pressure drop in the 4 in. dia. tail pipe (unshared).

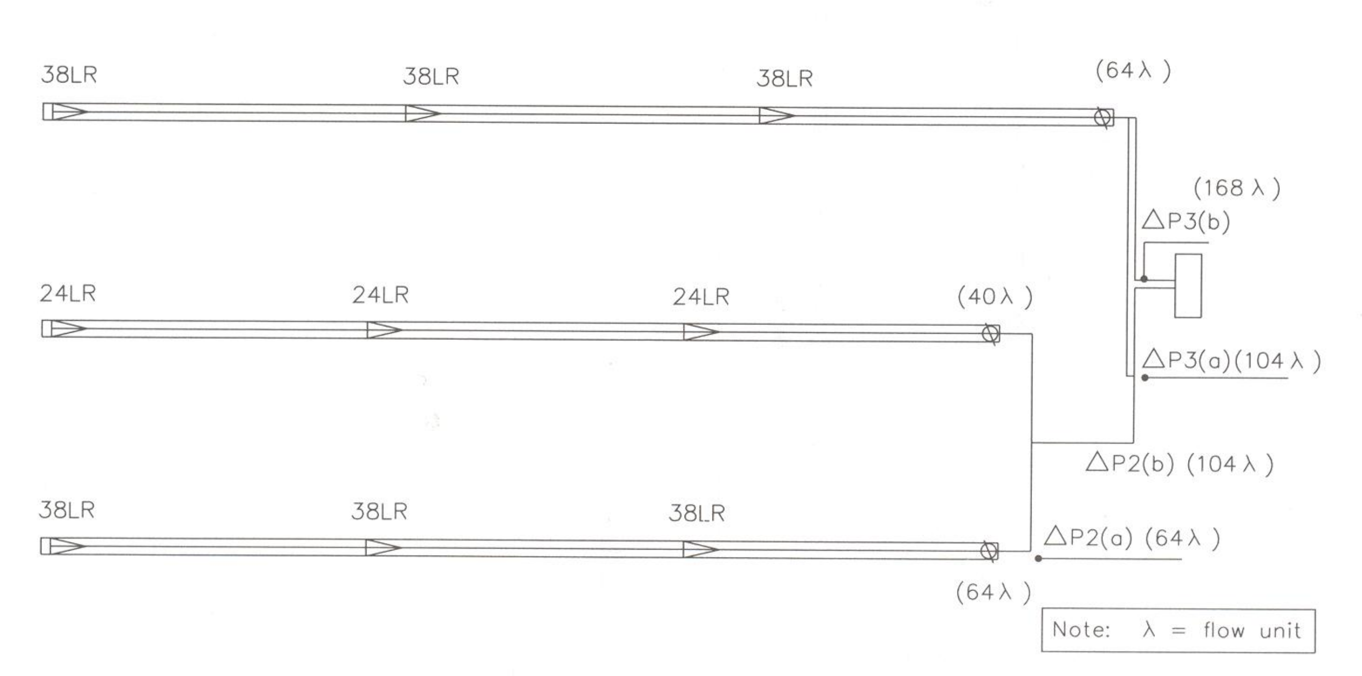
$\Delta P_{2(b)}$- Pressure drop in 4in. dia. shared tail pipe.

$\Delta P_{3(a)}$ - Pressure drop in this 6in. dia. tail pipe (unshared).

$\Delta P_{3(b)}$- Pressure drop in 6in. dia. shared tail pipe.

The resulting ΔP_T determines whether the tail pipe can be shared or should be split.

DIAGRAM 10. DIAGRAM OF ROUTE GIVING GREATEST PRESSURE DROP



14.2 TO DETERMINE ΔP_T IN A MULTI - RADIANT BRANCH SYSTEM:

ΔP_1 - The radiant branch with the greatest flow unit loading in the route giving the greatest pressure drop is plotted on the graph of diagram 6.

The pressure drop in the radiant branch can then be determined (in w.c).

ΔP_2 - The length of 4in. dia. tail pipe after the damper of the radiant branch in ΔP_1 to either the 4-6 in. reducer or a tee joining another 4in. dia. branch is calculated. This length and FLOW UNIT loading is then plotted on the graph of diagram 7. The pressure drop in this section of 4in. dia. tail pipe can then be determined (in w.c.). This would be $\Delta P_{2(a)}$.

If the 4in. dia. tail pipe joins at a tee with another tail pipe and remains in 4in. dia. after the tee, then ΔP_2 for this next section of 4in. dia. pipe must be calculated for the greater FLOW UNIT loading and length. This would be $\Delta P_{2(b)}$.

ΔP_3 - The length of 6in. dia. tail pipe after the 4-6 reducer in the route from the radiant branch in ΔP_1 to either the vacuum fan or a tee joining from another branch is calculated. This length and FLOW UNIT loading is then plotted on the graph of diagram 8. The pressure drop in this section of 6in. dia. tail pipe can then be determined (in w.c.). This would be $\Delta P_{3(a)}$.

If the 6in. tail pipe joins at a tee with another pipe, then ΔP_3 for this next section of 6 in. dia. pipe from the tee to the vacuum fan must be calculated for the greater FLOW UNIT loading and length. This would be $\Delta P_{3(b)}$.

Thus:
$\Delta P_T = \Delta P_1 + \Delta P_{2(a)} + \Delta P_{2(b)} + \Delta P_{3(a)} + \Delta P_{3(b)}$

The maximum length of shared 6in. dia. tail pipe, just prior to the fan, in excess of 200 flow unit loading is 6ft.

15 EXAMPLE OF DESIGN LAYOUT

The building as detailed in diagram 9, has a required system capacity of 532,000 Btu/h, see section 2 system capacity for calculation method.

The radiant branches are suspended at a height and position within the building to ensure a 6ft overlap of radiant spread is achieved.

15.1 RADIANT BRANCH A.

3 ARC 24 LR burners at 43ft centers.

The damper is positioned 43ft after the last burner in the line. At this position the pipe after the damper can be considered as tail pipe, even though the reflector covers it for 17ft.
(See Diagram 5).

Tail pipe requirement calculations:–
40 Flow Units x 1.2ft (4in. tail pipe length, per flow unit).
= 48ft of 4in. dia. tail pipe.
Thus, after the end of the reflector.

48 – 17 = 31ft tail pipe length is required.

15.2 RADIANT BRANCH B.

This is identical to radiant branch A, which has a requirement of 31ft of 4in. dia. tail pipe.

Radiant branches A & B manifold together between points E & F = 40ft.

Therefore (31 + 31) – 40 = 22ft of shared tail pipe from point G to fan.

15.3 RADIANT BRANCH C.

1 – ARC32LR burner with 59ft radiant branch.

32 flow units x 1.2ft (4in. tail pipe length per flow units) = 38ft of 4in. dia. tail pipe.

Radiant branch C tail pipe from point H to fan = 38ft.

To determine vacuum fan size, add together the total number of flow units per radiant branch and refer to section 9 table 2 for fan model.

Total System Flow Units 40 + 40 +32 = 112 flow units.

15.4 CALCULATING TOTAL SYSTEM PRESSURE DROP ΔP_T

15.4.1 Pressure drop in radiant branch ΔP_1:

40 FLOW UNITS
ΔP_1 = 4.8in. w.c.

15.4.2 Pressure drop $\Delta P_{2(a)}$ in 4in. dia. tail pipe from damper to point 'G' :

40 FLOW UNITS in 34ft of 4in. dia.
$\Delta P_{2(a)}$ = 0.4in w.c.

15.4.3 Pressure drop $\Delta P_{2(b)}$ in 4in. dia. tail pipe from point 'G' to fan :

80 FLOW UNITS in 18ft 4in. dia.
$\Delta P_{2(b)}$ = 1.2in. w.c.

15.4.4 $\Delta P_T = \Delta P_1 + \Delta P_{2(a)} + \Delta P_{2(b)}$

$\Delta P_T = 4.8 + 0.4 + 1.2 = 6.4$in. w.c.

15.4.5 Select fan to overcome 6.4 in. w.c. ΔP_T.

Continuous

'ARC' SERIES OPERATING INSTRUCTIONS

1. Ensure that gas supply is turned on at each burner.

2. Switch on electrical supply to heaters.

3. Set thermostats (if fitted) to call for heat or to temperature settings required.

4. The vacuum fan will purge for approximately 1 min. and then 'RED' neon lights will illuminate at each burner. The burners closest to the fan in each branch will light first, with both 'RED' and 'AMBER' neons illuminated at each burner.
   The next mid-branch burners will light after a time delay of approximately 25 seconds each. After approximately another 30 seconds the end vent burner will light.

5. If the lighting up sequence fails, switch off the electrical supply. After approximately 1 min switch on.

   If lighting up fails again refer to Installation and Service manual.

6. On reaching zone temperature the fan will purge for approximately 6 mins. with burners off.

7. **CAUTION**
   The heaters must be grounded. The ignition sequence depends upon a properly grounded circuit.

8. To switch off, turn off electrical supply.

9. The system must be installed and serviced regularly by a competent person in accordance with the technical manual, local and national codes.

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