RURAL AMBULANCE INFRASTRUCTURE RECONFIGURATION PROGRAM - FAIRY MEADOW

DISCIPLINE: HYDRAULICS SERVICES

CLIENT: NSW GOVERNMENT HEALTH INFRASTRUCTURE

SITE PLAN

SCALE: N.T.S.

DRAWING LIST

REVISIONS / AMENDMENTS

Rev	Date	Description	Verified
P1	01.07.22	PRELIMINARY ISSUE	S.L.
A	05.08.22	TENDER ISSUE	S.L.
1	30.09.22	CONTRACT SET ISSUE	S.L.

REVISIONS / AMENDMENTS

Rev	Date	Description	Verified

BUILDER: RAIR — Rural Ambulance Infrastructure Reconfiguration — Building the future response for our state

PROJECT MANAGER: mace — LEVEL 16, 44 MARKET STREET, SYDNEY NSW 2000, T +61 2 9299 3588

CLIENT: NSW GOVERNMENT Health Infrastructure — NSW Ambulance

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CONSULTANT: JHA — Level 23, 101 Miller Street, North Sydney NSW 2060 Australia, +61 (02) 9437 1000, general@jhaengineers.com.au, www.jhaservices.com

PROJECT: **RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW**

TITLE: **HYDRAULIC SERVICES**
COVER SHEET
AND DRAWING LIST

CONSTRUCTION ISSUE

DRAWN	S.L.
CHECKED	S.T.
APPROVED	S.T.
CREATED	MAY 2022
JOB No.	210067

SCALE @ A1: **N.T.S.**

DRAWING No.: **R23-HY-DRG-0000**

REV: **1**

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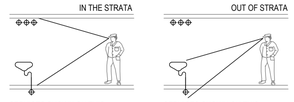
HYDRAULIC LEGEND

- COLD WATER SERVICE
- FIRE HOSE REEL SERVICE
- HOT WATER SERVICE
- HOT WATER FLOW
- HOT WATER RETURN
- WW — WARM WATER SERVICE
- WW — WARM WATER FLOW
- WW — WARM WATER RETURN
- FIRE HYDRANT SERVICE
- FIRE HOSE REEL SERVICE
- E — E — E — E — ELECTRICAL SERVICE
- e — EXISTING SERVICE
- SANITARY PLUMBING
- VENT PIPE
- SRM — SEWER RISING MAIN
- TW — TRADE WASTE DRAINAGE
- TW — TRADE WASTE PLUMBING
- TWV — TRADE WASTE VENT
- CV — CHAMBER VENT
- STORMWATER DRAINAGE
- DOWNPIPE
- OF — OVERFLOW PIPE
- EXISTING COLD WATER SERVICE
- EXISTING SEWER SERVICE
- EXISTING GAS SERVICE
- GAS SERVICE

SYSTEM ACCESSORIES LEGEND

- PUMP
- CO — CLEAROUT
- PIPELINE CONTINUES
- PIPELINE CAPPED OFF
- FHR — FIRE HOSE REEL
- FH — FIRE HYDRANT - INTERNAL
- DUAL FIRE HYDRANT - EXTERNAL
- OFG — OVERFLOW GULLY
- WM — WATER METER
- GM — GAS METER
- BT — BOUNDARY SHAFT
- DRAINAGE OUTLET
  - BTFW - BUCKET TRAP FLOOR WASTE
  - FW - FLOOR WASTE
  - PDO - PLANTER DRAIN OUTLET
  - RWO - RAIN WATER OUTLET
  - VFW - VINYL FLOOR WASTE
  - SDO - SPOON DRAIN OUTLET
  - CPD - CARPARK DRAIN
  - PD - PLANTER DRAIN
- SMH — MAINTENANCE HOLE
  - SMH - SEWERAGE MAINTENANCE HOLE
  - SWMH - STORMWATER MAINTENANCE HOLE
- SWP — STORMWATER PIT WITH GRATE
- SWS — STORMWATER SUMP WITH GRATE
- PECP — PUMP ELECTRICAL CONTROL PANEL
- PENETRATION CORE THROUGH STRUCTURAL ELEMENT
- IPMF — INDUCT PIPE MICA FLAP
- NEW JUNCTION INTO EXISTING PIPELINE
- NEW BRANCH INTO EXISTING PIPELINE
- TD — TUNDISH
- OFLOW — OVERLAND FLOW PATH
- POO PIT

DESIGN ZONES



SERVICES SHOWN ON THIS DRAWING ARE ABOVE SLAB

SERVICES SHOWN ON THIS DRAWING ARE BELOW SLAB

SYSTEM ACCESSORIES LEGEND

- BAV — BALANCING VALVE
- CV — STOP VALVE
- BV — BALL VALVE
- SV — SOLENOID VALVE
- MGV — MONITORED GATE VALVE
- PV — PATH VALVE IN CAST IRON SURFACE BOX
- GR — GAS REGULATOR
- RV — REFLUX VALVE
- NRV — NON RETURN VALVE
- DCV — DOUBLE CHECK VALVE
- TDCV — TESTABLE DOUBLE CHECK VALVE
- GV — GAS VALVE
- RPZD — REDUCED PRESSURE ZONE DEVICE
- AAV — AIR ADMITTANCE VALVE
- B — BASIN, SINK, SHOWER OR BATH TAP SET
- B — BASIN, SINK, SHOWER OR BATH CW TAP
- B — BASIN, SINK, SHOWER OR BATH HW TAP
- THERMOSTATIC MIXING VALVE
- TEMPERATURE GUARD
- H — STREET FIRE HYDRANT
- WATER METER ASSEMBLY WITH RPZD
- RISER
- DROPPER
- TEE RISER
- TEE DROPPER
- HWU — HOT WATER UNIT
- FIRE HYDRANT BRIGADE BOOSTER ASSEMBLY
- FLOW DIRECTION ARROW
- A — AMENDMENT SYMBOL
- INDICATES PIPE RISERS
- FS / 100 — INDICATES SERVICE TYPE, INDICATES SERVICE SIZE
- FS / 100 — INDICATES SERVICE TYPE, INDICATES SERVICE SIZE, INDICATES PIPE DROPPERS
- exFS / 100 — EXISTING SERVICES IDENTIFICATION. DROPPER / RISER / SIZE
- H-001 — FOR CONTINUATION REFER DRAWING No. H-...
- 4.5KG DRY POWDER EXTINGUISHER
- 5.0KG CO2 FIRE EXTINGUISHER
- 9.0KG FOAM EXTINGUISHER
- NEW FIRE BLANKET

VALVE ABBREVIATIONS

AST	- ANGLE STOP TAP
AAV	- AIR ADMITTANCE VALVE
AP	- ACCESS PANEL
AV	- AIR ELIMINATION VALVE
BFV	- BUTTERFLY VALVE
BV	- BALL VALVE (GAS)
BAV	- BALANCING VALVE
CV	- CHECK VALVE
CV	- CONTROL VALVE
DCV	- DUAL CHECK VALVE
DV	- DRAIN OR TEST VALVE
ESOV	- EMERGENCY SHUT OFF VALVE
FCV	- CONTROL VALVE
FHV	- FIRE HYDRANT VALVE
GV	- GATE VALVE
HFV	- HANDS FREE VALVE
HT	- HOSE TAP
IV	- ISOLATION VALVE
NRV	- NON RETURN VALVE
OPSD	- OVER PRESSURE SHUT OFF REGULATOR
PLV	- PRESSURE LIMITING VALVE
PRV	- PRESSURE REDUCTION VALVE
PTR	- PRESSURE/TEMPERATURE RELIEF VALVE
RGBV	- RECESSED GAS BAYONET VALVE
RPZD	- REDUCED PRESSURE ZONE DEVICE
RST	- RECESSED STOP TAP
RV	- REFLUX VALVE
STP	- STOP TAP
SV	- STOP VALVE
TDVC	- TESTABLE DUAL CHECK VALVE
TEV	- TEMPERING VALVE
TMV	- THERMOSTATIC MIXING VALVE
TPR	- TEMPERATURE AND PRESSURE RELIEF VALVE
TV	- THROTTLING VALVE
VCG	- VALVE GROUP

FLUID FLOW AND MATERIAL ABBREVIATIONS

AHD	- AUSTRALIAN HEIGHT DATUM
Br	- BRASS
BRH	- BLUE RHINO
CI	- CAST IRON
CONC	- CONCRETE
CICL	- CAST IRON CEMENT LINED
CP	- CHROME PLATED
Cu	- COPPER
DICL	- DUCTILE IRON CEMENTED LINE
FRC	- FIBRE GLASS REINFORCED CEMENT
FU	- FIXTURE UNITS
GMS	- GALVANISED MILD STEEL
HDPE	- HIGH DENSITY POLYETHYLENE
ID	- INSIDE DIAMETER
kPa	- PRESSURE IN KILOPASCALS
kW	- KILOWATT
L	- LITRES
L/s	- FLOW IN LITRES PER SECOND
mm	- MILLIMETRES
m	- METRES
m²	- METRES SQUARES
MDPE	- MEDIUM DENSITY POLYETHYLENE
MJ	- MEGAJOULE
m/s	- VELOCITY OF FLOW IN METRES PER SECOND
mHd	- PRESSURE IN METRES HEAD
OD	- OUTSIDE DIAMETER
PE	- POLYETHYLENE
PP	- POLYPROPYLENE
RCP	- REINFORCED CONCRETE PIPE
RHS	- RECTANGULAR HOLLOW SECTION GALVANISED STEEL
SS	- STAINLESS STEEL
PVC-U	- UNPLASTICISED POLYVINYL CHLORIDE
VCP	- VITRIFIED CLAY PIPE

GENERAL ABBREVIATIONS

AAV	- AIR ADMITTANCE VALVE
AFFL	- ABOVE FINISHED FLOOR LEVEL
AC	- AIR CONDITIONING
AD	- AERIAL DRAINAGE
B	- BASIN
BG	- BOX GUTTER
BID	- BIDET
BM	- BAIN-MARIE
BPS	- BED PAN STERILISER
BPW	- BED PAN WASHER
BT	- BOUNDARY TRAP
BU	- BUBBLERS
BRT	- BUBBLER TROUGH
BTH	- BATH
BWU	- BOILING WATER UNIT
CHW	- CHILLED WATER
CL	- CEILING LEVEL
CO	- CLEAROUT
CP	- CHROME PLATED
CS	- CLEANERS SINK
CTE	- CONNECT TO EXISTING
CV	- CHAMBER VENT
CW	- COLD WATER
D	- DRAINAGE
DCP	- DISCHARGE CONTROL PIT
DE	- DIESEL EXHAUST
DF	- DRINKING FOUNTAIN
DGGP	- DOUBLE GRATED GULLY PIT
DHB	- DISABLED PERSONS HANDWASH BASIN
DL	- DILUTION PIT
DP	- DOWNPIPE
DTU	- DRAINAGE TURN-UP
DW	- DISHWASHER MACHINE
DWC	- DISABLED PERSONS WATER CLOSET
DWG No.	- DRAWING NUMBER
DWV	- DRAINAGE WASTE AND VENT
EG	- EAVES GUTTER
EJ	- EXPANSION JOINT
EKI	- EXTENDED KERB INLET
EX	- EXISTING
EW	- EYE WASH
FD	- FIRE DRENCHER
FFL	- FINISHED FLOOR LEVEL
FGL	- FINISHED GROUND LEVEL
FH	- FIRE HYDRANT
FHBV	- FIRE HYDRANT BOOSTER VALVE
FHR	- FIRE HOSE REEL
FU	- FIXTURE UNIT
FW	- FLOOR WASTE
G	- GAS
GA	- GREASE ARRESTOR
GD	- GRATED DRAIN
GFW	- GARBAGE FLOOR WASTE
GST	- GREASE STACK
GT	- GAS TURRET
GL	- GROUND LEVEL
GO	- GUTTER OUTLET
GW	- GREASE WASTE
GWV	- GREASE WASTE VENT
GW	- GLASS WASHER
HD	- HEAVY DUTY
HP	- HIGH POINT
HP	- HOT PLATE
HL	- HIGH LEVEL
HR	- HALF ROUND
HT	- HOSE TAP
HW	- HOT WATER
HWF	- HOT WATER FLOW
HWH	- HOT WATER HEATER
HWR	- HOT WATER RETURN
HWU	- HOT WATER UNIT
IPMF	- INDUCT PIPE MICA FLAP
IRR	- IRRIGATION
IS	- INSPECTION SHAFT
IL	- INVERT LEVEL
IM	- ICE MACHINE
IO	- INSPECTION OPENING
K	- KAMLOK FITTING WITH CAP & CHAIN
KB	- KITCHEN BASIN
KHW	- KITCHEN HOT WATER
KIP	- KERB INLET PIPE
KS	- KITCHEN SINK
LD	- LIGHT DUTY
LL	- LOW LEVEL
LS	- LAB SINK
LT	- LAUNDRY TUB
LTG	- LONGITUDINAL TRENCH GRATE
MD	- MEDIUM DUTY
ML	- MID LEVEL
NPOW	- NON-POTABLE COLD WATER
No.	- NUMBER
OF	- OVERFLOW
OFG	- OVERFLOW GULLY
OSD	- ON SITE DETENTION TANK
PA	- PLASTER ARRESTOR
PCW	- POTABLE COLD WATER
PRO	- PARAPET RAINWATER OUTLET
QT	- QUENCHING TANK
REF	- REFRIGERATOR
RL	- REDUCED LEVEL
RPZD	- REDUCED PRESSURE ZONE DEVICE
RWO	- RAINWATER OUTLET
RV	- RELIEF VENT
SBF	- STANDARD BAYONET FITTING
SD	- SAFE DRAIN
SDU	- SANITARY NAPKIN DISPOSAL UNIT
SEP	- SIDE ENTRY PIT
SEW	- SEWER
SH	- SLOP HOPPER
SHR	- SHOWER
SIP	- SEWER INSPECTION PIT
SK	- SINK
SMH	- SEWER MANHOLE
SP	- SOIL PIPE
SRM	- SEWER RISING MAIN
SRO	- SIDE ROOF OUTLET
SS	- SUB-SOIL PIPE
SSHR	- SAFETY SHOWER
SSL	- STRUCTURAL SLAB LEVEL
ST	- SANITARY/DRAINAGE STACK
SW	- STORM WATER
SWMH	- STORMWATER MANHOLE
SWP	- STORM WATER PIT
SWRM	- STORMWATER RISING MAIN
TD	- TUNDISH
TK	- TOP OF KERB
TTD	- TRAPPED TUNDISH
TTG	- TRENCH GRATE
TW	- TRADE WASTE
TWL	- TOP WATER LEVEL
TYP	- TYPICAL
U/G	- UNDERGROUND
UNO	- UNLESS NOTED OTHERWISE
UR	- URINAL
U/S	- UNDERSIDE
USFL	- UNDERSIDE FLOOR LEVEL
VB	- VACUUM BREAKER
VB	- VANITY BASIN
VFW	- VINYL FLOOR WASTE
VP	- VENT PIPE
WC	- WATER CLOSET
WD	- WINDOW DRENCHER
WL	- WATER LEVEL
WM	- WASHING MACHINE
WME	- WATER METER
WP	- WASTE PIPE
WT	- WASH TROUGH
WW	- WARM WATER
WWF	- WARM WATER FLOW
WWR	- WARM WATER RETURN
YG	- YARD GULLY
Ø	- DIAMETER

GENERAL NOTES

1. THIS PLAN MUST NOT BE COPIED OR REPRODUCED IN ANY FORM OR USED FOR ANY PURPOSE OTHER THAN ORIGINALLY INTENDED WITHOUT APPROVAL FROM JHA CONSULTING ENGINEERS.
2. THIS PLAN SHALL BE READ IN CONJUNCTION WITH ALL ARCHITECTURAL, OTHER CONSULTANTS DRAWINGS, SPECIFICATIONS AND WITH SUCH OTHER WRITTEN INSTRUCTIONS AS MAY BE ISSUED DURING THE COURSE. REFER TO THE ARCHITECT FOR DECISIONS BEFORE PROCEEDING WITH ANY WORK.
3. ALL WORKS TO BE IN ACCORDANCE WITH THE HYDRAULIC SERVICES SPECIFICATION, AUTHORITIES REQUIREMENTS, PLUMBING CODE OF AUSTRALIA, AS3500, AS5601, AS 2444, AS 2419, AS 2118.1, AS2441, AS1530, CURRENT NCC & NSW HEALTH DEPT.
4. CONFIRM LOCATION, SIZE AND LEVELS OF ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF WORK.
5. DISCONNECT AND REMOVE ALL EXISTING REDUNDANT SERVICES TO AUTHORITIES APPROVAL.
6. LOCATIONS & FIXING OF PIPEWORK SHALL BE SUBJECT TO CO-ORDINATION WITH OTHER DESIGN DISCIPLINES, ie STRUCTURAL, MECHANICAL, ELECTRICAL AND OTHER SERVICES ENGINEERS.
7. ALL LOCATIONS OF EXISTING SERVICES MAINS TO BE CONFIRMED BY MEANS OF DIAL BEFORE YOU DIG, PIPE LOCATOR AND TRACING PRIOR TO COMMENCEMENT OF WORKS.
8. ALL WORKS TO INCLUDE TESTING & INSPECTIONS. OBTAIN REQUIRED CERTIFICATES ON COMPLETION & PAYMENT OF RELEVANT FEES.
9. THE HYDRAULIC CONTRACTOR SHALL ALLOW IN THE TENDER TO SUBMIT PHOTO BASED INSPECTION AND TEST PLANS ESPECIALLY FOR SERVICE PENETRATIONS THROUGH FIRE AND SMOKE WALLS. REFER TO ARCHITECTURAL DRAWINGS FOR DEMOLITION PLAN AND SCOPE OF WORKS.
10. ALLOW TO CLEAN / FLUSH OUT ALL EXISTING STORMWATER DRAINAGE.
11. ALLOW TO SAWCUT/REMOVE HARD SURFACES AREAS AS REQUIRED TO COMPLETE THE INSTALLATION. ALLOW TO MAKE GOOD SURFACES UPON COMPLETION.
12. CHECK EXISTING ELECTRICAL EARTHING TO METALLIC PLUMBING SERVICES. PROVIDE TEMPORARY EARTHING CABLES BETWEEN SERVICES WHICH ARE TO BE CUT, TERMINATED OR EXTENDED. CONFIRM WITH SITE ELECTRICIAN FOR SAFE PROCEDURES.
13. CONTRACTOR IS TO SET OUT & DIMENSION ALL PENETRATIONS & GAIN APPROVAL FROM STRUCTURAL ENGINEER BEFORE WORK COMMENCES. PROVIDE SEPARATE PENETRATION FOR EACH SERVICE SO AS TO ENSURE ADEQUATE FIRE STOPPING. ALL PIPE PENETRATIONS SHALL BE FITTED WITH APPROVED FIRE STOP COLLARS/ DEVICES TO CONFORM TO AS1530.
14. WATER, WASTE & GAS PIPES LOCATED WITHIN JOINERY CABINETS, SINK CUPBOARD etc. SHALL BE ARRANGED IN A MANNER SO AS NOT TO OBSTRUCT THE FREE SPACE AS FAR AS PRACTICAL INSTALLATION PERMITS.
15. PROVIDE FLOW CONTROL TO ALL FIXTURES. REFER FIXTURE/FAUCET SCHEDULE.
16. ALL WORK IS TO COMPLY WITH ALL AUTHORITY REQUIREMENTS, RELEVANT AUSTRALIAN STANDARDS AND THE NATIONAL CONSTRUCTION CODE.
17. THE DOCUMENTS REPRESENT DESIGN CONCEPT ONLY. IT IS THE SUB CONTRACTORS RESPONSIBILITY TO DEVELOP DETAILED DRAWINGS, FULLY CO-ORDINATED WITH ALL SERVICE DISCIPLINES, NEW AND EXISTING STRUCTURE AND ARCHITECTURAL DOCUMENTATION.
18. THE SUB-CONTRACTOR IS RESPONSIBLE FOR THE COMPLETE DETAILED DESIGN, CALCULATIONS AND SUBMISSIONS, SUPPLY AND INSTALLATION OF ALL SERVICES, CERTIFICATION AND APPROVALS, COMMISSIONING, TESTING & HANDOVER.
19. THE SUB-CONTRACTOR IS TO ALLOW FOR THE PAYMENT OF ALL FEES AND CHARGES LEVIED BY THE VARIOUS AUTHORITIES AND PREPARE ALL SUBMISSIONS AS REQUIRED TO FACILITATE THE CONSTRUCTION OF ALL SERVICES.
20. DO NOT SCALE DRAWINGS. WRITTEN DIMENSIONS GOVERN.
21. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
22. ALL DIMENSIONS SHALL BE VERIFIED ON SITE BEFORE PROCEEDING WITH THE WORK. THE CLIENT SHALL BE NOTIFIED IN WRITING OF ANY DISCREPANCIES.
23. THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT CONTRACTS, SPECIFICATIONS, REPORTS AND DRAWINGS.

REVISIONS / AMENDMENTS

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BUILDER

RAIR — Rural Ambulance Infrastructure Reconfiguration — Building the future response for our state

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PROJECT

RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE

HYDRAULIC SERVICES
HYDRAULIC LEGEND

CONSTRUCTION ISSUE

DRAWN	S.L.
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APPROVED	S.T.
CREATED	MAY 2022
JOB No.	210067

SCALE @ A1 **N.T.S.**

DRAWING No. **R23-HY-DRG-0001**

REV **1**

S:\JOB No\Job No 20210000-20210099\210067 RAIR Building Services Consultants\Drawings\Hydraulics\ Fairy Meadow\R23-HY-DRG-0001.dwg

150mm FOUR POIONT SUCTION AND FOUR POINT BOOSTER ASSEMEBLY APPROXIMATELY 15m FROM COWPER STREET

EXISTING PRIVATE FIRE MAIN

EXISTING PRIVATE GAS MAIN

EXISTING GAS METER FOR UNIVERSITY

EXISTING PRIVATE GAS MAIN

100mm AUTHORITY WATER MAIN

PROVIDE 40MM WATER METER TO POTABLE COLD WATER CONNECTION TO AUTHORITY'S REQUIREMENTS. PLUMBING SUBCONTRACTOR TO ALLOW TO SUBMIT ALL APPLICATIONS AND PAY ALL ASSOCIATED COSTS.

EXISTING SIGNAGE

EXISTING WATER METER

PROPOSED WATER MAIN EXTENSION

EXISTING PRIVATE WATER MAIN

EXISTING WATER METER FOR UNIVERSITY

PRIVATE EXTENSION INTO SITE FOR POTABLE WATER SUPPLY. CONTRACTOR IS TO MAKE ALL APPLICATIONS AND PAY ALL COSTS TO EXTEND FROM THE NEW WATER MAIN INTO THE LOT.

EXISTING BOLLARD

EXISTING DISH DRAIN

EXISTING WATER, GAS AND FIRE PIPING LOCATED WITHIN THE AMBULANCE LOT ARE TO BE COVERED BY EASEMENT IN FAVOR OFF THE UNIVERSITY LOT. THE BUILDER IS RESPONSIBLE TO PROVIDE ALL REQUIRED EASEMENTS.

WATER METER AND PIPING RETICULATION MUST BE CONFIRMED ON SITE. PIPING LOCATION HAS BEEN TAKEN FROM SURVEY DRAWING. CONTRACTOR IS RESPONSIBLE TO COORDINATE AND RELOCATE ALL EXISTING AND NEW SERVICES REQUIRED FOR THE NEW DEVELOPMENT.

EXISTING SITE BOUNDARY AND FENCE

EXISTING PRIVATE FIRE MAIN

EXISTING PRIVATE WATER MAIN

EXISTING PRIVATE GAS MAIN

PROPOSED SITE BOUNDARY

EXISTING PRIVATE WATER MAIN

PROPOSED WATER METER

DFH

PV

H-0200

OFFICE
OFFICE
ADMIN
ACC WC
COMMS
MSB
WASTE
DELIVERY
MEETING ROOM
CLEANER
MEDICAL STORE
PLANT ROOM
KITCHEN & DINING
CHARGE
OUTDOOR AREA
COMMON ROOM
MALE WC
SERVICES
OIL SEP
WASH BAY
GYM
LOCKERS
SLEEPING POD
SLEEPING POD
FEMALE WC

H-0100

IL: 4.26

uPVC Ø100 @ 1.65%

H-0100

IL: 3.67

uPVC Ø100 @ 1.65%

CO

uPVC Ø100 @ 1.65%

IL: 3.175

CO

IL: 2.95

IPMF

PROPOSED SITE BOUNDARY

PROPOSED SITE BOUNDARY

DN100 CO

NEW DN100 LOW LEVEL VENT LINE CONNECTED WITHIN 10M OF BOUNDARY TRAP AND EXTENDED INTO AMBULANCE LOT

INNOVATION WAY

PROPOSED BIORETENTION

SETBACK

EXISTING FLAG POLE

EXISTING GARDEN BED WITH ROCK EDGE

EXISTING BOLLARDS

IL: 2.44

BT WITH HEAVY DUTY CLASS D LID

PRIVATE SEWER EXTENSION AS UoW OWNED SITE INCLUDE AMBULANCE LOT

BOUNDARY TRAP DIRECTLY AFTER POINTY OF CONNECTION TO AUTHORITY MAIN

NEW DN150 JUNCTION TO EXISTING DN750 AUTHORITY WASTEWATER MAIN TO BE PROVIDED. PROVIDE SEPARATE PC SUM TO ENGAGE A WSC TO DESIGN THE NEW CONNECTION AND PROVIDE ANOTHER PC SUM TO INSTALL THE CONNECTION.

SYDNEY WATER WASTEWATER/ SEWER MAIN APPROX. 4m DEEP

BT

750 mm AUTHORITY SEWER MAIN

750 mm AUTHORITY SEWER MAIN

750 mm AUTHORITY SEWER MAIN

PROPOSED SMH

EXISTING PATH

EXISTING SIGNAGE

1 : 200-A1 1 : 400-A3

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Rural Ambulance Infrastructure Reconfiguration
Building the future response for our state

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
HYDRAULIC SERVICES
SITE PLAN

CONSTRUCTION ISSUE

DRAWN	S.L.
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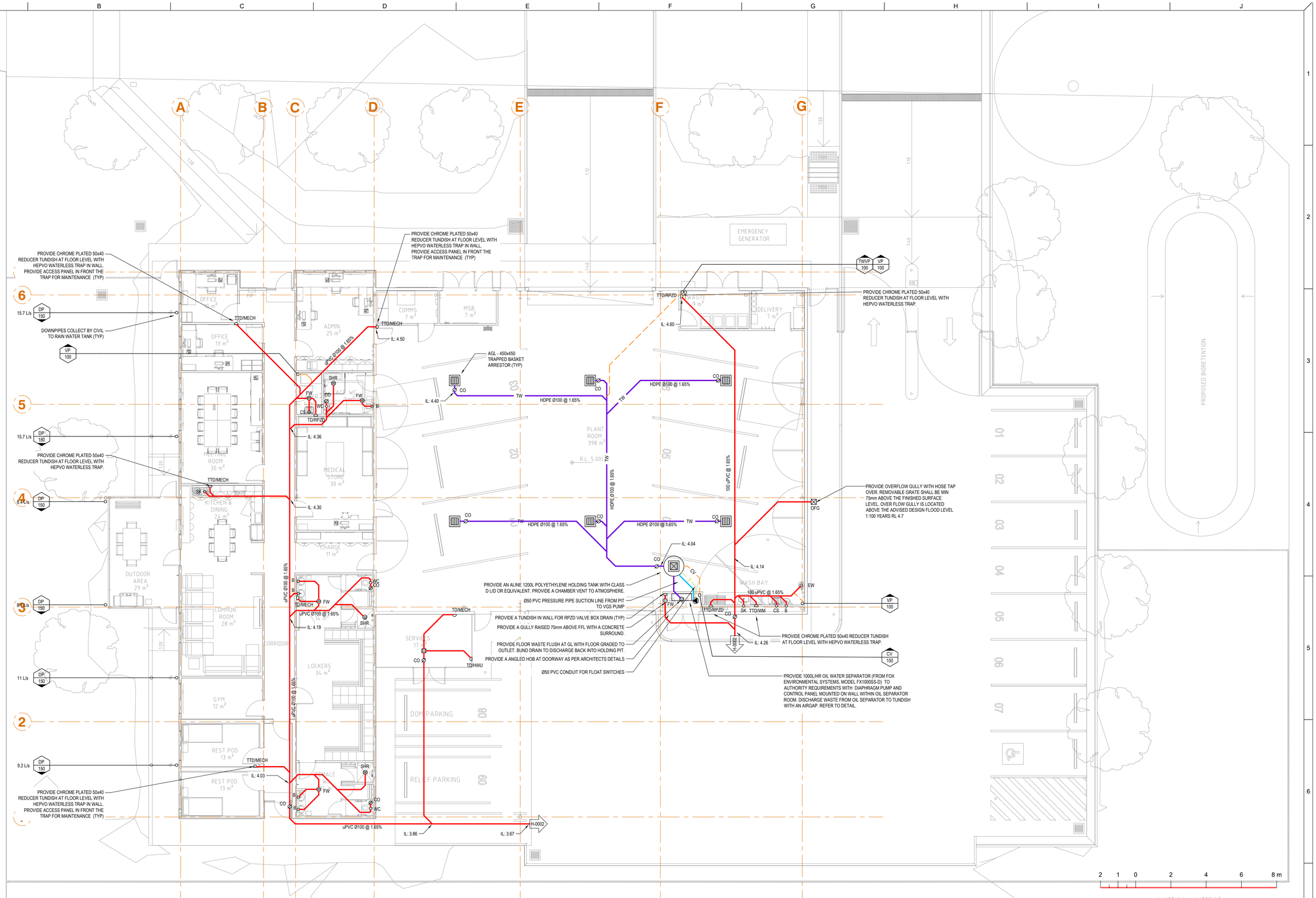
1:200

DRAWING No.
R23-HY-DRG-0002

REV
1

S:\JOB No\Job No 20210000-20210099\210067 RAIR Building Services Consultants\Drawings\Hydraulics\ Fairy Meadow\R23-HY-DRG-0002.dwg



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1	30.09.22	CONTRACT SET ISSUE	S.L.					

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Building the future response for our state

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
HYDRAULIC SERVICES
GROUND FLOOR
STORMWATER AND SEWER
LAYOUT

CONSTRUCTION ISSUE

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CHECKED	S.T.
APPROVED	S.T.
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SCALE @ A1 **1:100**

DRAWING No. **R23-HY-DRG-0100**

REV **1**

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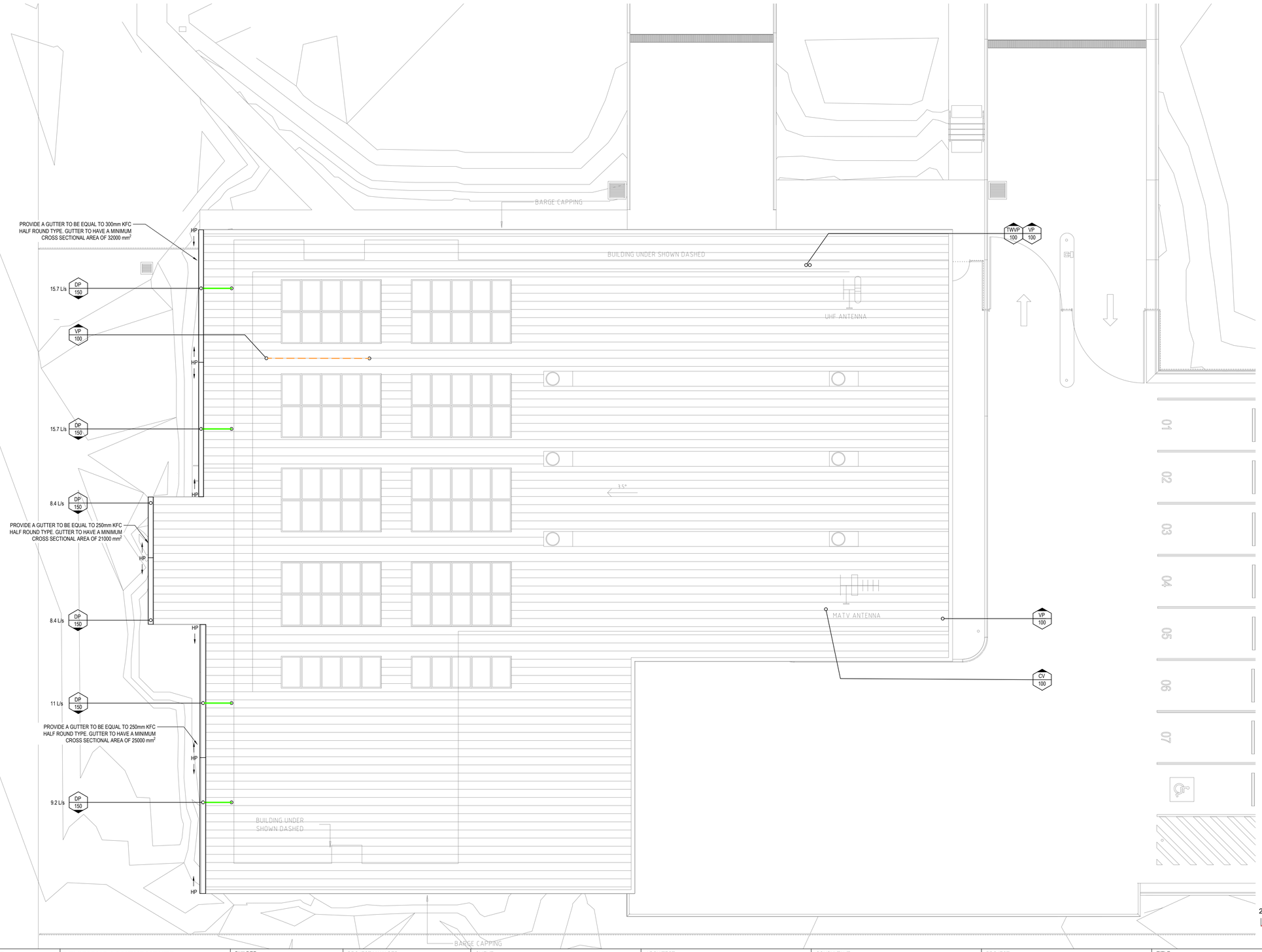

REVISIONS / AMENDMENTS

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REVISIONS / AMENDMENTS

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
HYDRAULIC SERVICES
ROOF PLAN
STORMWATER AND SEWER LAYOUT

CONSTRUCTION ISSUE

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APPROVED	S.T.
CREATED	MAY 2022
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1:100

DRAWING No.
R23-HY-DRG-0101

REV
1

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PROVIDE THERMOSTATIC MIXING VALVE SET AT 43°C IN A LOCKABLE STAINLESS STEEL BOX RECESSED IN WALL AT 1500AFFL C/C FOR ALL ACCESSIBLE ABLUTION FIXTURES. PROVIDE COLD AND WARM ISOLATIONS FOR BATHROOM GROUP WITHIN VALVE BOX. (TYPICAL ALL).

PROVIDE A THERMOSTATIC MIXING VALVE SET AT 50°C IN A LOCKABLE STAINLESS STEEL BOX RECESSED IN WALL AT 1500AFFL C/C FOR ALL NON ACCESSIBLE TOILETS. PROVIDE COLD AND WARM ISOLATIONS FOR BATHROOM GROUP WITHIN VALVE BOX. (TYPICAL ALL).

PROVIDE HOSE TAP IN LANDSCAPING / OUTDOOR AREA AT LOW LEVEL

PROVIDE HOSE TAP IN LANDSCAPING

PROVIDE HOSE TAP IN LANDSCAPING / OUTDOOR AREA AT LOW LEVEL

PROVIDE A HOSE TAP ON TOP OF OVER FLOW GULLY

PROVIDE HOSE TAP IN LANDSCAPING / OUTDOOR AREA AT LOW LEVEL

PROVIDE VANDALPROOF HOSE TAP WITH VACUUM BREAKER LOCATED ON ALL IN ACCESSIBLE LATION. SHOWN HERE FOR INFORMATION ONLY .

FLOW AND RETURN PUMPSET LOCATED ON WALL AT 1200MM AFFL.

PROVIDE RHEEM 315L ELECTRIC HOT WATER UNIT (1 x 4.8kW ELEMENT) WITH FLOW AND RETURN PUMPSET IN A DUTY STANDBY ARRANAGEMENT. DUTY OF 0.1L/s @ 2mH. REFER TO SPECIFICATION.

4.5KG DRY POWDER EXTINGUISHER
9.0KG FOAM EXTINGUISHER

PROVIDE A THERMOSTATIC MIXING VALVE SET AT 50°C IN A LOCKABLE STAINLESS STEEL BOX RECESSED IN WALL AT 1500AFFL C/C FOR ALL NON ACCESSIBLE TOILETS. PROVIDE COLD AND WARM ISOLATIONS FOR BATHROOM GROUP WITHIN VALVE BOX. (TYPICAL ALL).

2 1 0 2 4 6 8 m

1 : 100-A1 1 : 200-A3

REVISIONS / AMENDMENTS					REVISIONS / AMENDMENTS				
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All dimensions to be verified on site/s prior to commencement of on-site work and/ or off-site prefabrication. Figured dimension to be taken in preference to scaled dimensions. This drawing is copyright and remains the property of JHA Consulting Engineers. Reproduction in whole or part of these drawings without written consent constitutes an infringement of copyright.

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
HYDRAULIC SERVICES
GROUND FLOOR
PRESSURE SERVICES
LAYOUT

CONSTRUCTION ISSUE

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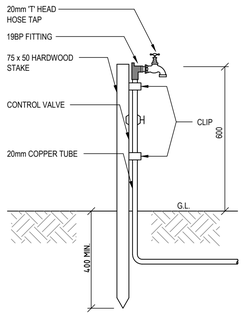
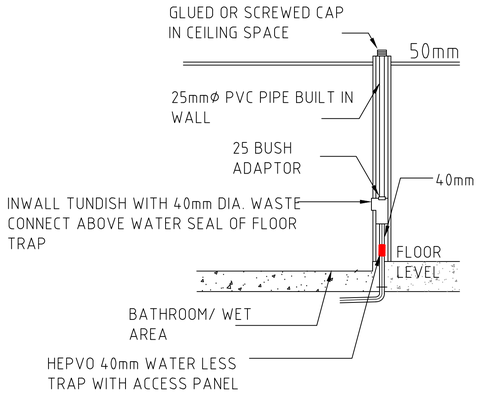
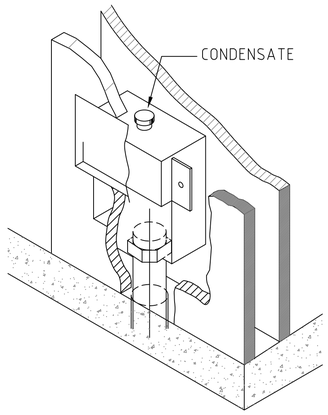


HOSE TAP DETAIL
NOT TO SCALE

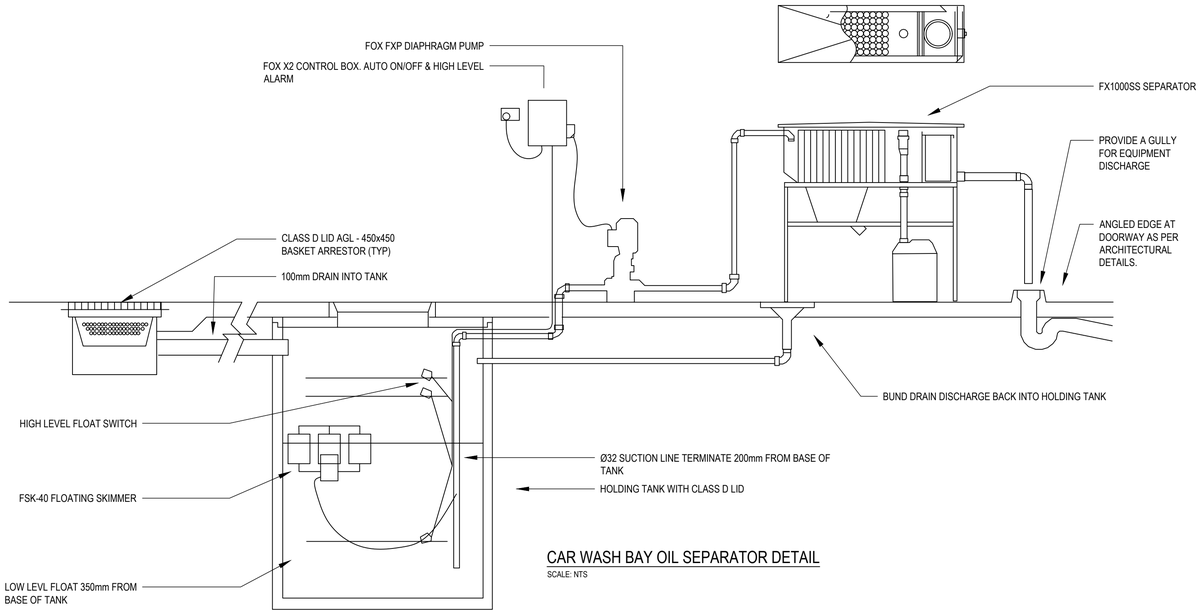


ELEVATION VIEW



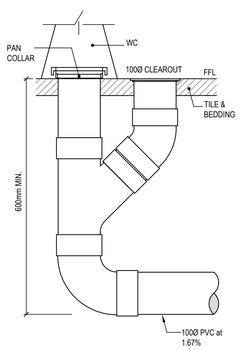
ISOMETRIC VIEW

MODTECH INWALL TUNDISH CONNECTING TO A WATERLESS TRAP
NOT TO SCALE

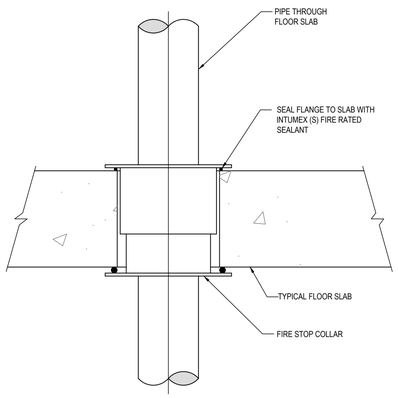


CAR WASH BAY OIL SEPARATOR DETAIL
SCALE: NTS

TYPICAL VENT TERMINATION DETAIL
NOT TO SCALE



WC CLEAROUT DETAIL
NOT TO SCALE



PIPE PENETRATION WITH FIRE STOP COLLAR
SCALE N.T.S.

SIDE ELEVATION

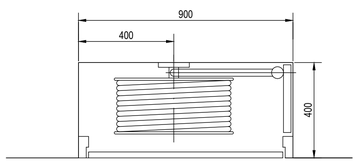
FRONT ELEVATION (OPEN)

FRONT ELEVATION (CLOSED)

NOTE:
HOT & COLD WATER FEED PIPEWORK TO TMV IS NOT TO HAVE ANY BRANCHES WITHIN 1m OF TMV

ENWARE AQUABLEND 1500, FOUR POINT THERMOSTATIC MIXING VALVE/CONTROL VALVE GROUP BOX
NOT TO SCALE

ELEVATION



PLAN

TYPICAL FIRE HOSE REEL CABINET
SCALE: NTS

REVISIONS / AMENDMENTS				REVISIONS / AMENDMENTS			
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BUILDER: RAIR — Rural Ambulance Infrastructure Reconfiguration — Building the future response for our state

PROJECT MANAGER: LEVEL 16, 44 MARKET STREET, SYDNEY NSW 2000, T +61 2 9299 3566 — mace

CLIENT: NSW GOVERNMENT Health Infrastructure — NSW Ambulance

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PROJECT: **RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW**

TITLE: **HYDRAULIC SERVICES** HYDRAULIC DETAIL SHEET

CONSTRUCTION ISSUE

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RURAL AMBULANCE INFRASTRUCTURE RECONFIGURATION PROGRAM - FAIRY MEADOW

DISCIPLINE: MECHANICAL SERVICES

CLIENT: NSW GOVERNMENT HEALTH INFRASTRUCTURE

SITE PLAN
SCALE: N.T.S.

DRAWING LIST

REVISIONS / AMENDMENTS

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
MECHANICAL SERVICES
COVER SHEET
AND DRAWING LIST

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REV **1**

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LEGEND

AxB — RECTANGULAR SHEET METAL DUCTWORK, UN-INSULATED
A- DUCT SIZE (mm) SIDE VIEWED
B- DUCT SIZE (mm) SIDE IN SECOND AXES

ALL DUCTWORK SHALL COMPLY WITH AS4254 AND AS1668.
ALL DUCT DIMENSIONS INDICATED ON THE DRAWINGS ARE CLEAR INTERNAL AIRWAY SIZES.

50mm INTERNAL INSULATION

ACOUSTICALLY INSULATED SHEET METAL DUCTWORK, MINIMUM 50mm THICKNESS @ min 30kg/m³ DENSITY.

AxB — DUCT SPIGOT WITH BUTTERFLY DAMPER ON RECTANGULAR DUCTWORK

ALL DUCTWORK SHALL COMPLY WITH AS4254 AND AS1668. ALL DUCT DIMENSIONS INDICATED ON THE DRAWINGS. SQUARE, RECTANGULAR AND ROUND DUCTS ARE REPRESENT AS CLEAR INTERNAL AIRWAY SIZES UNLESS NOTED OTHERWISE FLAT OVAL DUCT DIMENSIONS REPRESENT SHEET METAL SIZE. (AN ALLOWANCE FOR INTERNAL INSULATION HAS BEEN MADE).

SHEET METAL DUCTWORK LAGGED WITH:

R1.2 — EXTERNAL / INTERNAL INSULATION AS DESCRIBED WITHIN SPECIFICATION TYPICALLY WITH A MINIMUM THERMAL INSULATION RESISTANCE OF 1.2m²K/W

R2.0 — EXTERNAL / INTERNAL INSULATION AS DESCRIBED WITHIN SPECIFICATION TYPICALLY WITH A MINIMUM THERMAL INSULATION RESISTANCE OF 2.0m²K/W

R3.0 — EXTERNAL / INTERNAL INSULATION AS DESCRIBED WITHIN SPECIFICATION TYPICALLY WITH A MINIMUM THERMAL INSULATION RESISTANCE OF 3.0m²K/W

FD — FIRE DAMPER

ROOF MOUNTED COWL

FLEXIBLE DUCTWORK CONNECTION

SUPPLY/EXHAUST FAN

NEW FLEXIBLE DUCTWORK

100 l/s 600x600 — SWIRL SUPPLY AIR DIFFUSER, SUPPLYING 100 l/s, 600x600 FACE, WITH PLENUM BOX.

RETURN / EXHAUST EGGCRATE C/W RETURN AIR PLUNUM.

ACCESS PANEL, BY BUILDING TRADE

MSSB — MECHANICAL SERVICES SWITCHBOARD (MSSB)

CEILING MOUNTED DUCTED FAN COIL UNIT

CEILING MOUNTED CASSETTE A/C UNIT

WALL MOUNTED A/C UNIT

OUTDOOR CONDENSER UNIT

VRV/VRF TYPE VERTICAL DISCHARGE CONDENSER UNIT

WALL MOUNTED PAD WITH BUILT IN TEMPERATURE SENSOR

IN DUCT SMOKE PROBE

EF- — EXHAUST FAN

OAF- — OUTSIDE AIR FAN

FCU- — INDOOR AC UNIT

CU- — CONDENSER UNIT

CONDENSATE DRAIN LINE

FW — FLOOR WASTE (BY OTHERS).

TD — TUNDISH (BY OTHERS).

C — REVISION

20mm UNDERCUT TO DOOR, BY BUILDING TRADE

DOOR RELIEF GRILLE SUPPLIED BY MECHANICAL TRADE FOR INSTALLATION BY BUILDING TRADE

A A — SECTION

REFRIGERANT DETECTION ALARM / GAS LEAK DETECTION SENSOR

C — WALL MOUNTED AC MASTER CONTROLLER

VOLUME CONTROL DAMPER

TRANSFER AIR DUCT

FLEXIBLE DUCT SIZING SCHEDULE

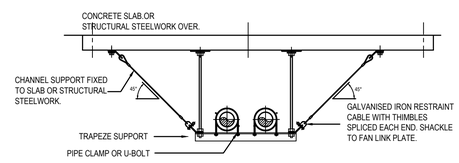
AIR QUANTITY (L/S)	FLEX. DUCT DIAM. (MM)
0 to 100	200 DIA
101 to 150	250 DIA
151 to 220	300 DIA
221 to 330	350 DIA
331 to 425	400 DIA

DOOR GRILLE SIZING SCHEDULE

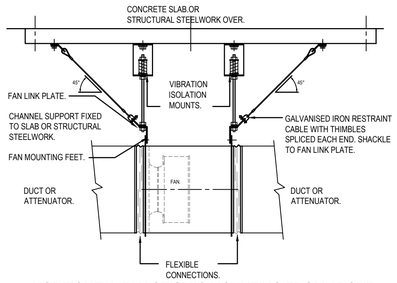
AIR FLOW (L/S)	SIZE (MM x MM)
0 to 150	600 x 150
151 to 200	600 x 200
201 to 300	600 x 300
301 to 500	600 x 450
501 to 600	600 x 600

NOTES

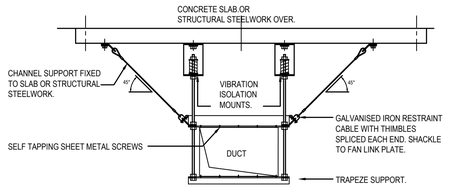
1. INFORMATION SHOWN IS FOR TENDER PURPOSE ONLY.
2. THE MECHANICAL TRADE SHALL CO-ORDINATE WITH ALL SERVICES ON SITE PRIOR TO MANUFACTURE AND SITE INSTALLATION.
3. ALL DUCTWORK INSULATION INCLUDING FLEXIBLE DUCTWORK TO BE AS NOTED ON DRAWINGS OR AS DESCRIBED IN THE MECHANICAL SPECIFICATIONS.
4. IF THERE IS ANY DISCREPANCY BETWEEN MECHANICAL AND ACOUSTIC REQUIREMENTS REGARDING DUCT INTERNAL INSULATION, ACOUSTIC REQUIREMENTS WILL TAKE PRECEDENCE.
5. WHERE THE DIAMETER OF THE FLEXIBLE DUCT EXCEEDS THE DEPTH OF THE RIGID DUCT IT ORIGINATES FROM, AN OVAL SPIGOT HAVING THE SAME CIRCUMFERENCE AS THE FLEXIBLE DUCT, MAY BE USED.
6. REFER TO SCHEDULE FOR FLEXIBLE DUCT DIAMETERS. THE LENGTH OF FLEXIBLE DUCT SHALL NOT EXCEED 3.6m. WHERE THE DISTANCE BETWEEN OUTLET AND SPIGOT IS GREATER THAN 3.6m, A SECTION OF RIGID CIRCULAR OR OVAL DUCT OF THE SAME DIAMETER SHALL BE USED TO MAKE UP THE DIFFERENCE. THE SECTION OF RIGID CIRCULAR OR OVAL DUCT HAS NOT BEEN SHOWN ON DRAWINGS FOR CLARITY REASONS.
7. A FULL SIZE CONDENSATE DRAIN (OR 25mm DIAMETER MINIMUM) SHALL RUN FROM EACH AIR CONDITIONING UNIT TO A TUNDISH OR FLOOR WASTE. CONDENSATE DRAIN PIPES SHALL BE PVC OR COPPER. SHOULD COPPER PIPE BE USED IT SHOULD BE INSULATED WITH 10mm THICK ARMAFLEX OR APPROVED EQUAL INSULATION.
8. THE LOCATION OF GRILLES AND DIFFUSERS IN PLASTER CEILING SHOWN ON MECHANICAL DRAWINGS IS INDICATIVE ONLY. FOR EXACT LOCATION REFER TO ARCHITECTURAL REFLECTED CEILING PLAN DRAWINGS.
9. ALL ACCESS PANELS IN THE PLASTER CEILING (FOR FIRE DAMPERS, VCD's AND EQUIPMENT) TO BE PROVIDED BY THE BUILDING TRADE.
10. TUNDISHES AND/OR FLOOR WASTES ASSOCIATED WITH MECHANICAL SERVICES TO BE PROVIDED BY HYDRAULIC TRADE.
11. FAN COIL UNITS (FCU'S) SHALL BE MOUNTED ON SPRINGS TYPE SLFH FROM MASON INDUSTRIES, HAVING 25mm STATIC DEFLECTION OR EQUIVALENT. FANS SHALL BE ISOLATED FROM DUCTWORK WITH FLEXIBLE CONNECTIONS.
12. ALL CONDENSING PIPES PENETRATIONS SHALL BE ISOLATED USING A FIRE-RATED MASTIC SEALANT HAVING SPECIFIC GRAVITY OF 1.6g.



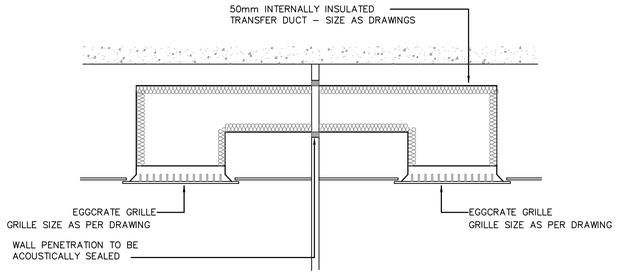
HORIZONTAL PIPEWORK SEISMIC MOUNTING FROM ABOVE
N.T.S



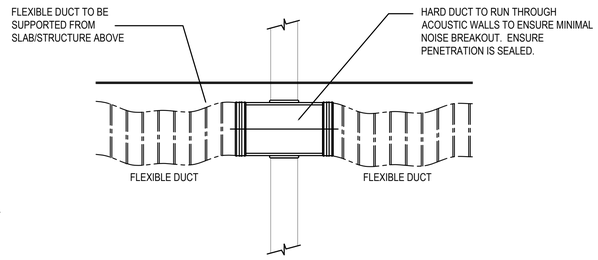
HORIZONTAL FAN SEISMIC MOUNTING FROM ABOVE
N.T.S



HORIZONTAL DUCT SEISMIC MOUNTING FROM ABOVE
N.T.S



1 – DETAIL OF TRANSFER DUCT / GRILLES



WALL PENETRATION FOR FLEXIBLE DUCTWORK DETAIL
N.T.S.

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PROJECT: **RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW**

TITLE: **MECHANICAL SERVICES**
MECHANICAL LEGEND

CONSTRUCTION ISSUE

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REV: **1**

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MSB ROOM TO BE NATURALLY VENTILATED VIA THE USE OF FULLY LOUVRED DOORS.

WALL MOUNTED SPLIT SYSTEM TO SERVE COMMS ROOM.

1000x500 OUTSIDE AIR LOUVRE C/W PANEL FILTER.

TUNDISH TO BE PROVIDED BY HYDRAULIC CONTRACTOR (TYPICAL)

WHERE FLEXIBLE DUCTWORK CROSSES FULL HEIGHT WALL, PROVIDE A RIGID SHEETMETAL PIECE AT THE PENETRATION. (TYPICAL)

LOW LEVEL DOOR GRILLE

CEILING DUCTED FAN COIL UNIT (FCU) (TYPICAL)

400x400 DOMESTIC TYPE RANGEHOOD EXHAUST LOUVRE. LOUVRE TO BE 1m FROM BUILDING OPENING.

WALL MOUNTED A/C CONTROLLER C/W INBUILT TEMPERATURE SENSOR (TYPICAL).

FIRE DAMPER (TYPICAL).

COMPACT TYPE CEILING CASSETTE TO SERVE SLEEPING PODS.

200x200 OUTSIDE AIR LOUVRE C/W PANEL FILTER.

1000x450 TOILET EXHAUST LOUVRE. DISCHARGE POINT TO BE MINIMUM 3m FROM BUILDING OPENING AND SITE BOUNDARY.

PERFORATED ROLLER SHUTTER. FREE AREA % SUBJECT TO FINAL SELECTION.

6m² LOUVRE AREA REQUIRED TO OPPOSITE ENDS OF THE PLANT ENCLOSURE TO ACHIEVE NATURAL VENTILATION.
NOTE. OPENINGS ARE TO BE EVENLY DISTRIBUTED.

WASTE ROOM TO BE NATURALLY VENTILATED VIA THE USE OF FULLY LOUVRED DOORS.

DELIVERY ROOM TO BE NATURALLY VENTILATED VIA THE USE OF FULLY LOUVRED DOORS.

HIGH LEVEL TRANSFER DUCT TO PROVIDE NATURAL VENTILATION COVERAGE TO THE PLANT ENCLOSURE.

INTERNAL DOOR SERVING WASTE ROOM TO BE SOLID TO MINIMISE RISK OF ODOUR INTO PLANT ROOM.

PROVIDE MANUAL SWITCH CONTROL TO OPERATE THE ELECTRIC DAMPER ASSOCIATED WITH THE ROOF VENTILATORS

PROVIDE AN AC CENTRALISED CONTROLLER TO MONITOR AND CONTROL AC UNITS

PROVIDE 6-OFF ROOF VENTILATORS C/W ELECTRICAL OPERATED DAMPERS (EDMONDS HURRICANE H900 OR SIMILAR).

2-OFF SIDE DISCHARGE CONDENSERS DOUBLE STACKED. 1-OFF TO SERVE COMMS ROOM & 1-OFF TO SERVE SLEEPING PODS.
ALLOW TO PROVIDE NECESSARY BRACKETING

OIL SEPARATOR TO BE NATURALLY VENTILATED VIA THE USE OF FULLY LOUVERED DOORS.

EXPOSED REFRIGERANT PIPEWORK TO BE ENCLOSED WITHIN COLOURBOND DUCTING TO MATCH BUILDING COLOUR.

TOP DISCHARGE VRV / VRF CONDENSER. ALL MECHANICAL PLANT TO BE PROVIDED WITH ANTI-CORROSION PROTECTION (BLYGOLD OR APPROVED EQUAL).

MECHANICAL SERVICES SWITCHBOARD

2 1 0 2 4 6 8 m

1 : 100-A1 1 : 200-A3

REVISIONS / AMENDMENTS			
Rev	Date	Description	Verified
P1	01.07.22	PRELIMINARY ISSUE	N.P.
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1	30.09.22	CONTRACT SET ISSUE	N.P.

REVISIONS / AMENDMENTS			
Rev	Date	Description	Verified

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
MECHANICAL SERVICES
GROUND FLOOR
AIR CONDITIONING AND VENTILATION
LAYOUT

CONSTRUCTION ISSUE

DRAWN	N.P.	SCALE @ A1	
CHECKED	R.A.	**1:100**	
APPROVED	R.A.		
CREATED	MAY 2022		
JOB No.	210067		
DRAWING No.		REV	
R23-ME-DRG-0100		**1**	

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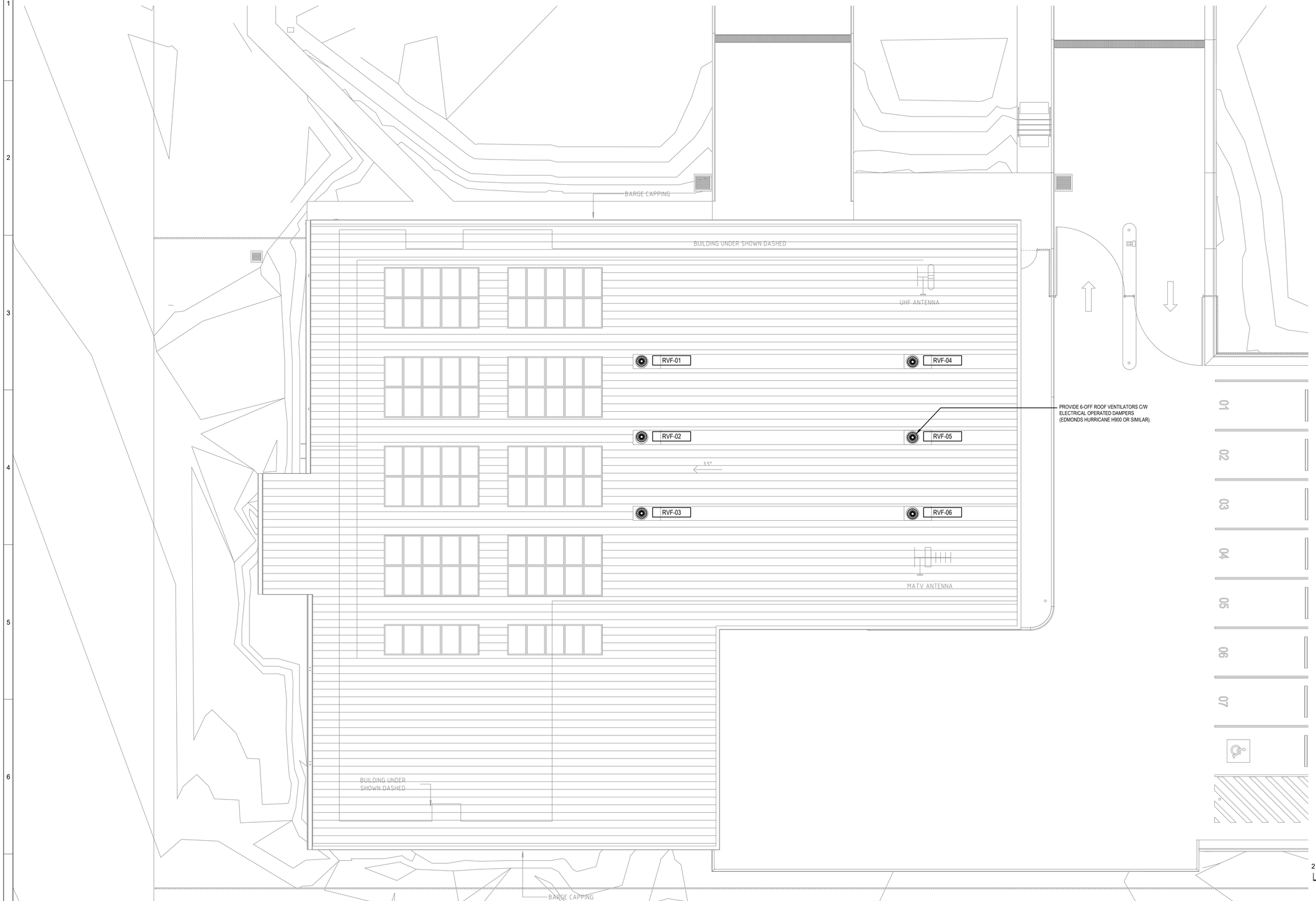

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
MECHANICAL SERVICES
ROOF PLAN
AIR CONDITIONING AND VENTILATION
LAYOUT

CONSTRUCTION ISSUE

DRAWN	N.P.	SCALE @ A1
CHECKED	R.A.	**1:100**
APPROVED	R.A.	
CREATED	MAY 2022	
JOB No.	210067	

DRAWING No. **R23-ME-DRG-0101**
REV **1**

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DOCUMENT TRANSMITTAL

Electrical Services

Project Name: RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

Project Number: 210067

Date	01	05	30	17
Month	07	08	09	11
Year	22	22	22	22
Sent By	JG	JG	JG	JG

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Reason For Issue **P** - Preliminary **T** - Tender **C** - Construction **I** - For Information **A** - For Approval	Current Set	P	T	C	C
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Document Title	No.	Revision				
Cover Sheet And Drawing List	R23-EL-DRG-0000	**1**	P1	A	1	
Electrical Legend	R23-EL-DRG-0001	**1**	P1	A	1	
Site Plan	R23-EL-DRG-0002	**2**	P1	A	1	2
Ground Floor Lighting And Fire Detection Layout	R23-EL-DRG-0100	**2**	P1	A	1	2
Ground Floor Power And Communications Layout	R23-EL-DRG-0200	**2**	P1	A	1	2
Roof Plan Power And Communications Layout	R23-EL-DRG-0201	**1**	P1	A	1	
Electrical Schematics	R23-EL-DRG-0300	**2**		A	1	2
Electrical Services Specification	R23-EL-SPF-0001	**1**		A	1	

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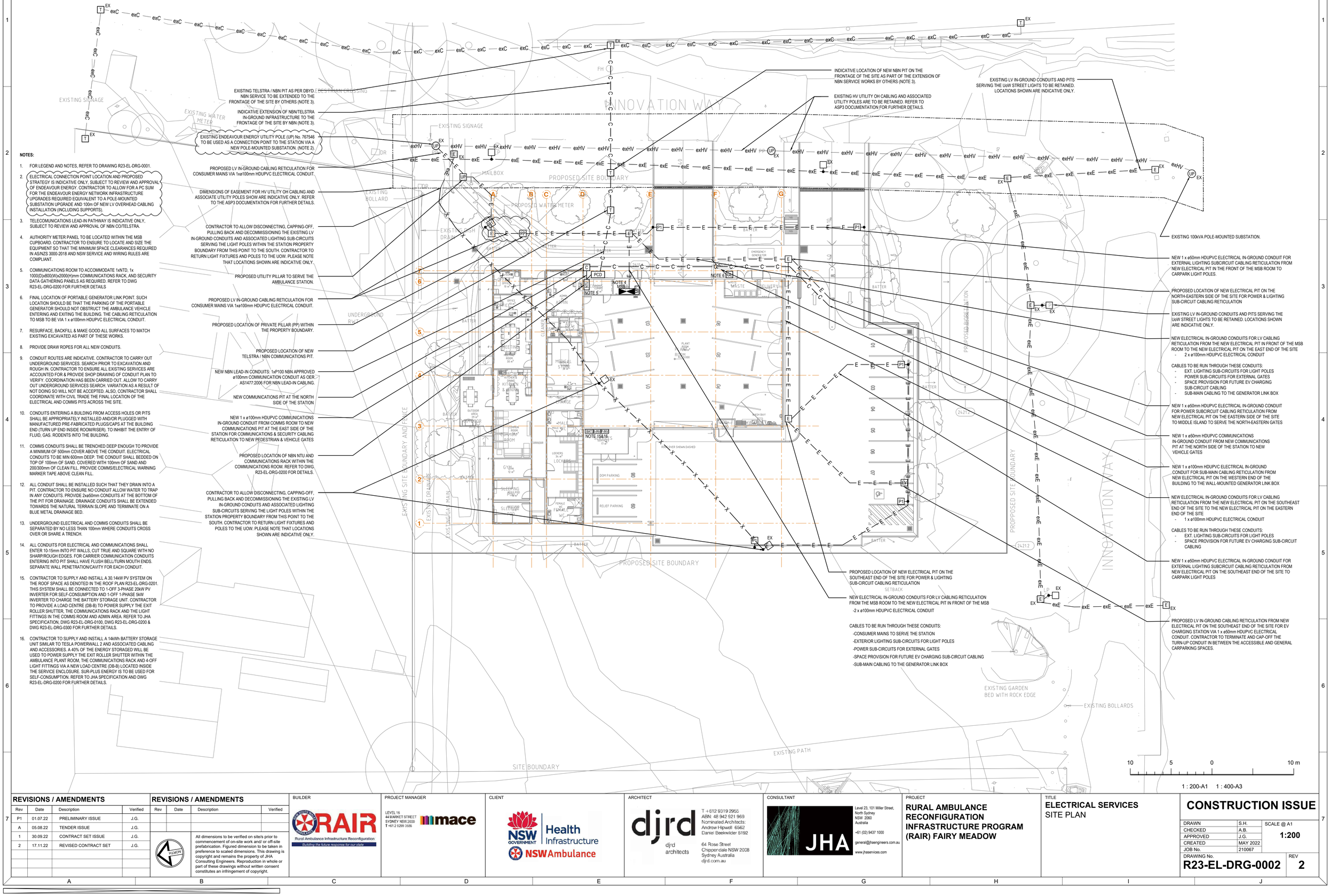

NOTES:

1. FOR LEGEND AND NOTES, REFER TO DRAWING R23-EL-DRG-0001.
2. ELECTRICAL CONNECTION POINT LOCATION AND PROPOSED STRATEGY IS INDICATIVE ONLY, SUBJECT TO REVIEW AND APPROVAL OF ENDEAVOUR ENERGY. CONTRACTOR TO ALLOW FOR A PC SUM FOR THE ENDEAVOUR ENERGY NETWORK INFRASTRUCTURE UPGRADES REQUIRED EQUIVALENT TO A POLE-MOUNTED SUBSTATION UPGRADE AND 100m OF NEW LV OVERHEAD CABLING INSTALLATION (INCLUDING SUPPORTS).
3. TELECOMMUNICATIONS LEAD-IN PATHWAY IS INDICATIVE ONLY, SUBJECT TO REVIEW AND APPROVAL OF NBN CO/TELSTRA.
4. AUTHORITY METER PANEL TO BE LOCATED WITHIN THE MSB CUPBOARD. CONTRACTOR TO ENSURE TO LOCATE AND SIZE THE EQUIPMENT SO THAT THE MINIMUM SPACE CLEARANCES REQUIRED IN AS/NZS 3000-2018 AND NSW SERVICE AND WIRING RULES ARE COMPLIANT.
5. COMMUNICATIONS ROOM TO ACCOMMODATE 1xNTD, 1x 1000(D)x800(W)x2000(H)mm COMMUNICATIONS RACK, AND SECURITY DATA GATHERING PANELS AS REQUIRED. REFER TO DWG R23-EL-DRG-0200 FOR FURTHER DETAILS
6. FINAL LOCATION OF PORTABLE GENERATOR LINK POINT. SUCH LOCATION SHOULD BE THAT THE PARKING OF THE PORTABLE GENERATOR SHOULD NOT OBSTRUCT THE AMBULANCE VEHICLE ENTERING AND EXITING THE BUILDING. THE CABLING RETICULATION TO MSB TO BE VIA 1 x ø100mm HDUPVC ELECTRICAL CONDUIT.
7. RESURFACE, BACKFILL & MAKE GOOD ALL SURFACES TO MATCH EXISTING EXCAVATED AS PART OF THESE WORKS.
8. PROVIDE DRAW ROPES FOR ALL NEW CONDUITS.
9. CONDUIT ROUTES ARE INDICATIVE. CONTRACTOR TO CARRY OUT UNDERGROUND SERVICES, SEARCH PRIOR TO EXCAVATION AND ROUGH IN. CONTRACTOR TO ENSURE ALL EXISTING SERVICES ARE ACCOUNTED FOR & PROVIDE SHOP DRAWING OF CONDUIT PLAN TO VERIFY. COORDINATION HAS BEEN CARRIED OUT. ALLOW TO CARRY OUT UNDERGROUND SERVICES SEARCH. VARIATION AS A RESULT OF NOT DOING SO WILL NOT BE ACCEPTED. ALSO, CONTRACTOR SHALL COORDINATE WITH CIVIL TRADE THE FINAL LOCATION OF THE ELECTRICAL AND COMMS PITS ACROSS THE SITE.
10. CONDUITS ENTERING A BUILDING FROM ACCESS HOLES OR PITS SHALL BE APPROPRIATELY INSTALLED AND/OR PLUGGED WITH MANUFACTURED PRE-FABRICATED PLUGS/CAPS AT THE BUILDING END (TURN UP END INSIDE ROOM/RISER). TO INHIBIT THE ENTRY OF FLUID, GAS, RODENTS INTO THE BUILDING.
11. COMMS CONDUITS SHALL BE TRENCHED DEEP ENOUGH TO PROVIDE A MINIMUM OF 500mm COVER ABOVE THE CONDUIT. ELECTRICAL CONDUITS TO BE MIN 600mm DEEP. THE CONDUIT SHALL BEDDED ON TOP OF 100mm OF SAND. COVERED WITH 100mm OF SAND AND 200/300mm OF CLEAN FILL. PROVIDE COMMS/ELECTRICAL WARNING MARKER TAPE ABOVE CLEAN FILL.
12. ALL CONDUIT SHALL BE INSTALLED SUCH THAT THEY DRAIN INTO A PIT. CONTRACTOR TO ENSURE NO CONDUIT ALLOW WATER TO TRAP IN ANY CONDUITS. PROVIDE 2xø50mm CONDUITS AT THE BOTTOM OF THE PIT FOR DRAINAGE. DRAINAGE CONDUITS SHALL BE EXTENDED TOWARDS THE NATURAL TERRAIN SLOPE AND TERMINATE ON A BLUE METAL DRAINAGE BED.
13. UNDERGROUND ELECTRICAL AND COMMS CONDUITS SHALL BE SEPARATED BY NO LESS THAN 100mm WHERE CONDUITS CROSS OVER OR SHARE A TRENCH.
14. ALL CONDUITS FOR ELECTRICAL AND COMMUNICATIONS SHALL ENTER 10-15mm INTO PIT WALLS, CUT TRUE AND SQUARE WITH NO SHARP/ROUGH EDGES. FOR CARRIER COMMUNICATION CONDUITS ENTERING INTO PIT SHALL HAVE FLUSH BELL/TURN MOUTH ENDS. SEPARATE WALL PENETRATION/CAVITY FOR EACH CONDUIT.
15. CONTRACTOR TO SUPPLY AND INSTALL A 30.14kW PV SYSTEM ON THE ROOF SPACE AS DENOTED IN THE ROOF PLAN R23-EL-DRG-0201. THIS SYSTEM SHALL BE CONNECTED TO 1-OFF 3-PHASE 20kW PV INVERTER FOR SELF-CONSUMPTION AND 1-OFF 1-PHASE 5kW INVERTER TO CHARGE THE BATTERY STORAGE UNIT. CONTRACTOR TO PROVIDE A LOAD CENTRE (DB-B) TO POWER SUPPLY THE EXIT ROLLER SHUTTER. THE COMMUNICATIONS RACK AND THE LIGHT FITTINGS IN THE COMMS ROOM AND ADMIN AREA. REFER TO JHA SPECIFICATION, DWG R23-EL-DRG-0100, DWG R23-EL-DRG-0200 & DWG R23-EL-DRG-0300 FOR FURTHER DETAILS.
16. CONTRACTOR TO SUPPLY AND INSTALL A 14kWh BATTERY STORAGE UNIT SIMILAR TO TESLA POWERWALL 2 AND ASSOCIATED CABLING AND ACCESSORIES. A 40% OF THE ENERGY STORAGED WILL BE USED TO POWER SUPPLY THE EXIT ROLLER SHUTTER WITHIN THE AMBULANCE PLANT ROOM, THE COMMUNICATIONS RACK AND 4-OFF LIGHT FITTINGS VIA A NEW LOAD CENTRE (DB-B) LOCATED INSIDE THE SERVICE ENCLOSURE. SUR-PLUS ENERGY IS TO BE USED FOR SELF-CONSUMPTION. REFER TO JHA SPECIFICATION AND DWG R23-EL-DRG-0200 FOR FURTHER DETAILS.

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
ELECTRICAL SERVICES
SITE PLAN

CONSTRUCTION ISSUE

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APPROVED	J.G.		
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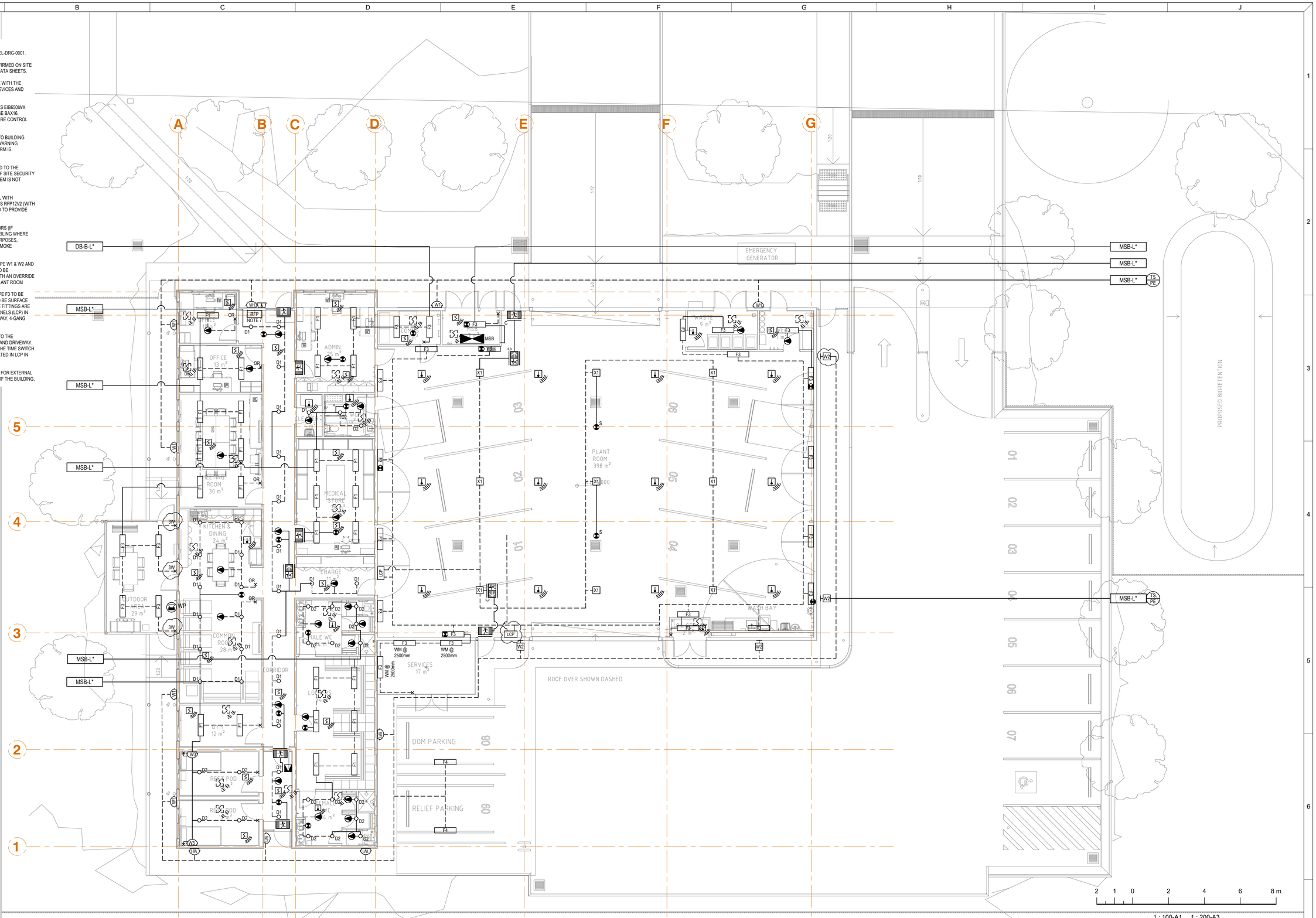
JOB No.	210067		
DRAWING No.	R23-EL-DRG-0002	REV	2

NOTES:

1. FOR LEGEND AND NOTES, REFER TO DRAWING R23-EL-DRG-0001.
2. FINAL LOCATION OF ALL EQUIPMENT SHALL BE CONFIRMED ON SITE AND WITH REFERENCE TO ARCHITECTURAL ROOM DATA SHEETS.
3. THE ELECTRICAL CONTRACTOR MUST CO-ORDINATE WITH THE OTHER TRADES BEFORE INSTALLING ELECTRICAL DEVICES AND EQUIPMENT.
4. ALL SMOKE/HEAT ALARMS TO BE SIMILAR TO BROOKS EIB650WX (SMOKE) AND EIB803CX (HEAT) WITH INTERFACE BASE BAX16. DEVICES TO BE CONNECTED TO THE RESIDENTIAL FIRE CONTROL PANEL
5. SMOKE AND THERMAL ALARMS TO BE CONNECTED TO BUILDING OCCUPANT WARMING SYSTEM (BOWS) TO INITIATE WARNING SYSTEM IN CASE ANY OF THE SMOKE/ THERMAL ALARM IS TRIGGERED.
6. SMOKE/THERMAL ALARM SYSTEM TO BE CONNECTED TO THE SECURITY SYSTEM AND INITIATE SIGNAL TO THE OFF SITE SECURITY COMPANY IN CASE IF SMOKE/THERMAL ALARM SYSTEM IS NOT RESETTED IN CLIENT DEFINE TIME.
7. SEMI-RECESSED RESIDENTIAL FIRE CONTROL PANEL WITH INTEGRATED BACK-UP BATTERY, SIMILAR TO BROOKS RFP12V2 (WITH ZONE OUTPUT CARD SUB365). BATTERY TO BE SIZED TO PROVIDE POWER TO RFP PANEL FOR AT LEAST 72 HOURS.
8. CONTRACTOR TO ADD ADDITIONAL SMOKE DETECTORS (IF REQUIRED) IN ANY CONCEALED AREA ABOVE THE CEILING WHERE THE HEIGHT IS MORE THAN 800mm. FOR TENDER PURPOSES, CONTRACTOR TO ALLOW FOR 15-OFF CONCEALED SMOKE DETECTORS WITH FAMCO BRACKETS
9. PERIMETER EXTERNAL WALL MOUNTED FITTINGS TYPE W1 & W2 AND EXTERNAL SURFACE-MOUNTED FITTINGS TYPE F4 TO BE CONTROLLED BY THE TIME SWITCH / PHOTOCELL WITH AN OVERRIDE OFF SWITCH LOCATED IN LCP IN THE AMBULANCE PLANT ROOM
10. PERIMETER INTERNAL WALL MOUNTED FITTINGS TYPE F3 TO BE MOUNTED AT 3.5m AFFL. LIGHT FITTINGS TYPE X1 TO BE SURFACE MOUNTED ON THE UNDERSIDE OF THE ROOF. THESE FITTINGS ARE TO BE CONTROLLED BY TWO LIGHTING CONTROL PANELS (LCP) IN THE AMBULANCE PLANT ROOM. THE LCP TO BE A 2-WAY, 4-GANG LIGHT SWITCH.
11. REFER TO DWG R23-EL-DRG-0002 FOR REFERENCE TO THE EXTERNAL LIGHTING FOR THE ON-GRADE CARPARK AND DRIVEWAY. SUCH LIGHT FITTINGS ARE TO BE CONTROLLED BY THE TIME SWITCH / PHOTOCELL WITH AN OVERRIDE OFF SWITCH LOCATED IN LCP IN THE AMBULANCE PLANT ROOM.
12. CONTRACTOR TO SUPPLY AND INSTALL PHOTOCELL FOR EXTERNAL LIGHTING CONTROL ON THE NORTH-EAST CORNER OF THE BUILDING, EXTERNALLY.



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NORTH

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
ELECTRICAL SERVICES
GROUND FLOOR
LIGHTING AND FIRE DETECTION
LAYOUT

CONSTRUCTION ISSUE

DRAWN	S.H.	SCALE @ A1
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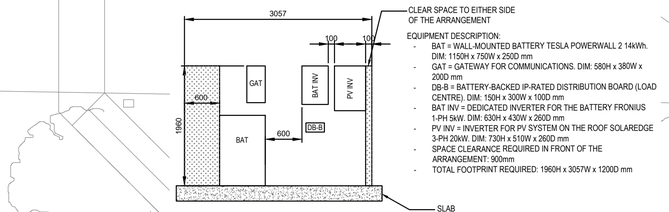
JOB No.	210067	

DRAWING No. **R23-EL-DRG-0100**
REV **2**

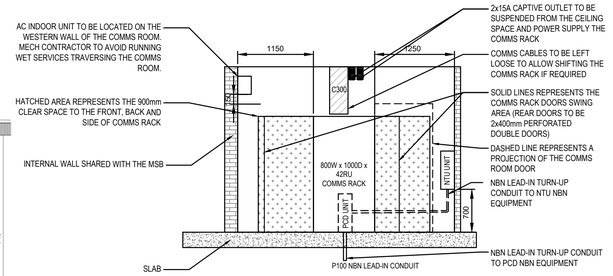
NOTES:

1. FOR LEGEND AND NOTES, REFER TO DRAWING R23-EL-DRG-0001.
2. THE ELECTRICAL AND COMMUNICATIONS CONTRACTORS MUST CO-ORDINATE WITH OTHER TRADES WHEN INSTALLING POWER AND DATA OUTLETS. REFER TO ARCHITECTURAL ROOM DATA SHEETS AS REQUIRED. IF UNSURE OF LOCATIONS, SUBMIT AND RFI FOR REVIEW AND CLARIFICATION.
3. FINAL LOCATION OF ALL EQUIPMENT SHALL BE CONFIRMED ON SITE AND WITH REFERENCE TO ARCHITECTURAL ROOM DATA SHEETS.
4. THE ELECTRICAL CONTRACTOR MUST CO-ORDINATE WITH THE OTHER TRADES WHEN INSTALLING POWER OUTLETS FOR THEIR EQUIPMENT. REFER TO OTHER TRADES DOCUMENTATION FOR FURTHER DETAILS.
5. GPOs DENOTED WITH THE LABEL "AB, BAT" ARE TO BE FED FROM THE BATTERY-BACKED DB DB-B. THESE OUTLETS ARE TO HAVE BLUE COVER-PLATE AND BLUE FINISH.
6. CONTRACTOR TO SUPPLY AND INSTALL A GENERATOR LINK BOX RATED AT 140A TO CONNECT A MOBILE DIESEL GENERATOR TO BACK-UP THE SITE IN CASE OF POWER OUTAGE. REFER TO DWG R23-EL-DRG-0300 FOR FURTHER DETAILS.
7. FINAL QUANTITIES AND LOCATION OF POWER AND DATA OUTLETS FOR MEDICAL STORE ROOM TO BE COORDINATED WITH SPACE LOGIC FURNITURE LAYOUTS.
8. ROLLER DOORS TO BE PROVIDED WITH INTERNAL BEAM DETECTION TO PREVENT THEM FROM CLOSING IF OBSTACLE IS IN THE WAY. ROLLER DOORS SHOULD NOT AUTOMATICALLY CLOSE WHEN ON BATTERY BACK UP POWER SUPPLY.
9. DATA OUTLETS FOR FUTURE PROVISIONS OF CCTV CAMERAS ARE TO BE PROVIDED AND INSTALLED AS SHOWN. CCTV ARE NOT REQUIRED TO BE PROVIDED AT THIS STAGE AS REQUESTED BY THE CLIENT.
10. NOT USED.
11. ALL EXTERNAL ACCESS CONTROL EQUIPMENT TO BE MINIMUM IP65 AND IK08 RATED. BUILDING PERIMETER DOORS WITH ELECTRONIC ACCESS CONTROL ARE TO BE CONFIGURED AS SAFE-SECURED.
12. VEHICLE INDUCTION LOOP TO OPERATE ONLY IN CASE THE DOOR IS IN PROCESS OF CLOSING. IF THE INDUCTION LOOP IS DETECTING VEHICLE DOOR SHOULD OPEN ONLY IN CASE IT IS IN PROCESS OF CLOSING. SIMILAR TO FUNCTIONING PRINCIPLE OF BEAM DETECTOR MOUNTED ON THE SIDE OF THE ROLLER DOORS. INDUCTION LOOP SHOULD NOT BE PASSING THROUGH ANY KIND OF CONSTRUCTION JOINTS. PROVIDE NECESSARY CONNECTION TO THE CAR PARK DOOR CONTROLLER TO MANUFACTURE'S REQUIREMENTS.
13. PUSH (MUSHROOM) BUTTON TO CONTROL EXIT AMBULANCE PLANT ROLLER SHUTTER DOOR FOR EARLY OPENING IN CASE OF EMERGENCY CALL. PROVIDE APPROPRIATE LABELING TO DIFFERENTIATE THE BUTTON.
14. DATA OUTLETS FOR PHONE AND SIP ARE TO BE ABOVE WHITEBOARDS/JOINERY. COORDINATE EXACT LOCATION ON SITE.
15. WALL MOUNTED SPEAKER ABOVE THE PHONE. SPEAKER TO BE CONNECTED TO THE PHONE BELOW. SPEAKER SHOULD AMPLIFY RING TONE OF THE PHONE SO IT WOULD BE POSSIBLE TO HEAR PHONE RINGING REGARDLESS OF THE BACKGROUND NOISE PRODUCED BY EQUIPMENT IN THE WASH BAY AND WHILE WASHING OF THE VEHICLES IS ONGOING.
16. SPACE PROVISIONS REQUIRED FOR A 3-PH 20kW & 1-PH 5kW PV INVERTERS AND 14kWh BATERY STORAGE WITHIN THE SERVICES ENCLOSURE: 1900W x 1200D x 1900H mm. INCLUDES 900mm IN FRONT OF THE ARRANGEMENT. REFER TO ELEVATION DETAIL ON THE TOP LEFT CORNER OF THIS DWG FOR AN ELEVATION VIEW OF THE PV SYSTEM ARRANGEMENT.
17. A 1-PH 14kWh BATTERY STORAGE TO BE INSTALLED WITHIN THE SERVICE ENCLOSURE. REFER TO THE TOP LEFT CORNER OF THIS DWG FOR AN ELEVATION VIEW OF THE PV SYSTEM ARRANGEMENT.
18. CONTRACTOR TO SUPPLY AND INSTALL 1xø80mm HDPVC COMMUNICATIONS CONDUITS AND ASSOCIATED WEATHERPROOF ROOF PENETRATIONS FROM THE UHF AND MATV ANTENNAS IN THE ROOF TO THE COMMS ROOM (1-OFF PER ANTENNA). THESE PENETRATION SHALL BE DONE OUTSIDE THE COMMS ROOM FOOTPRINT. REFER TO DWG R23-EL-DRG-0201 FOR PROPOSED LOCATION OF EACH ANTENNA.
19. NBN LEAD-IN CONDUITS FROM THE EXTERNAL NBN PIT SHALL BE TERMINATED WITH A TURN-UP CONDUIT DIRECTLY BELOW THE PCD EQUIPMENT. EXTERNALLY TO THE BUILDING FACADE. A NEW NBN LEAD-IN CONDUIT SHALL BE INSTALLED FROM THIS POINT TO THE COMMS ROOM, AND THE TURN-UP CONDUIT SHALL BE TERMINATED ON THE TOP-RIGHT CORNER OF THE COMMS ROOM, DIRECTLY BELOW THE NTU UNIT. REFER TO DWG R23-EL-DRG-0002 FOR EXTERNAL CARRIER CABLING RETICULATION. FROM THIS POINT.
20. NOT USED.
21. ELECTRICAL CONSUMER MAINS TURN-UP CONDUITS TO BE TERMINATED BELOW THE MSB. REFER TO DWG R23-EL-DRG-0002 FOR EXTERNAL IN-GROUND CABLING RETICULATION.
22. CONTRACTOR TO PROVIDE A INTERCOM SYSTEM TO BE CONNECTED TO THE VoIP PHONE SYSTEM. REFER TO NSW AMBULANCE SECURITY SPECIFICATION FOR FURTHER DETAILS CONTRACTOR TO REVISE THE INSTALLATION MANUALS OF THE NOMINATED INTERCOM SYSTEM TO AVOID CAT6A F/UTP CABLE DAMAGE WHEN INSTALLING THE INTERCOM FRONT LID.
23. ACCESS CONTROL SYSTEM TO BE PROVIDED WITH ADDITIONAL BATTERY PACKS TO ACHIEVE A 24H AUTONOMY OF THE SYSTEM.
24. PROVIDE INTERCOM STATION & PIN/PROXIMITY CARD COMBO DEVICE, CCTV MOUNTED ON DUAL HEIGHT BOLLARD ON THE LEFT SIDE OF THE DRIVEWAY. FINAL LOCATION TO BE COORDINATED WITH THE CLIENT ON SITE. CONTRACTOR TO REVISE THE INSTALLATION MANUALS OF THE NOMINATED INTERCOM SYSTEM TO AVOID CAT6A F/UTP CABLE DAMAGE WHEN INSTALLING THE INTERCOM FRONT LID.
25. CONTRACTOR TO SUPPLY AND INSTALL THE FOLLOWING IN-GROUND ELECTRICAL & COMMUNICATIONS CONDUITS TO SERVE THE FLOOR BOX FROM THE NORTHERN WALL IN MEETING ROOM: 2xø32mm ELECTRICAL & 2xø32mm COMMS CONDUITS. HDMI PORTS BEHIND DISPLAYS TO BE WIRED BACK TO TABLE BOX.
26. CONTRACTOR TO PROVIDE DOUBLE-POLE SWITCH ISOLATOR FOR THE OVEN AND COOKTOP AND LOCATE THEM ABOVE BENCH.



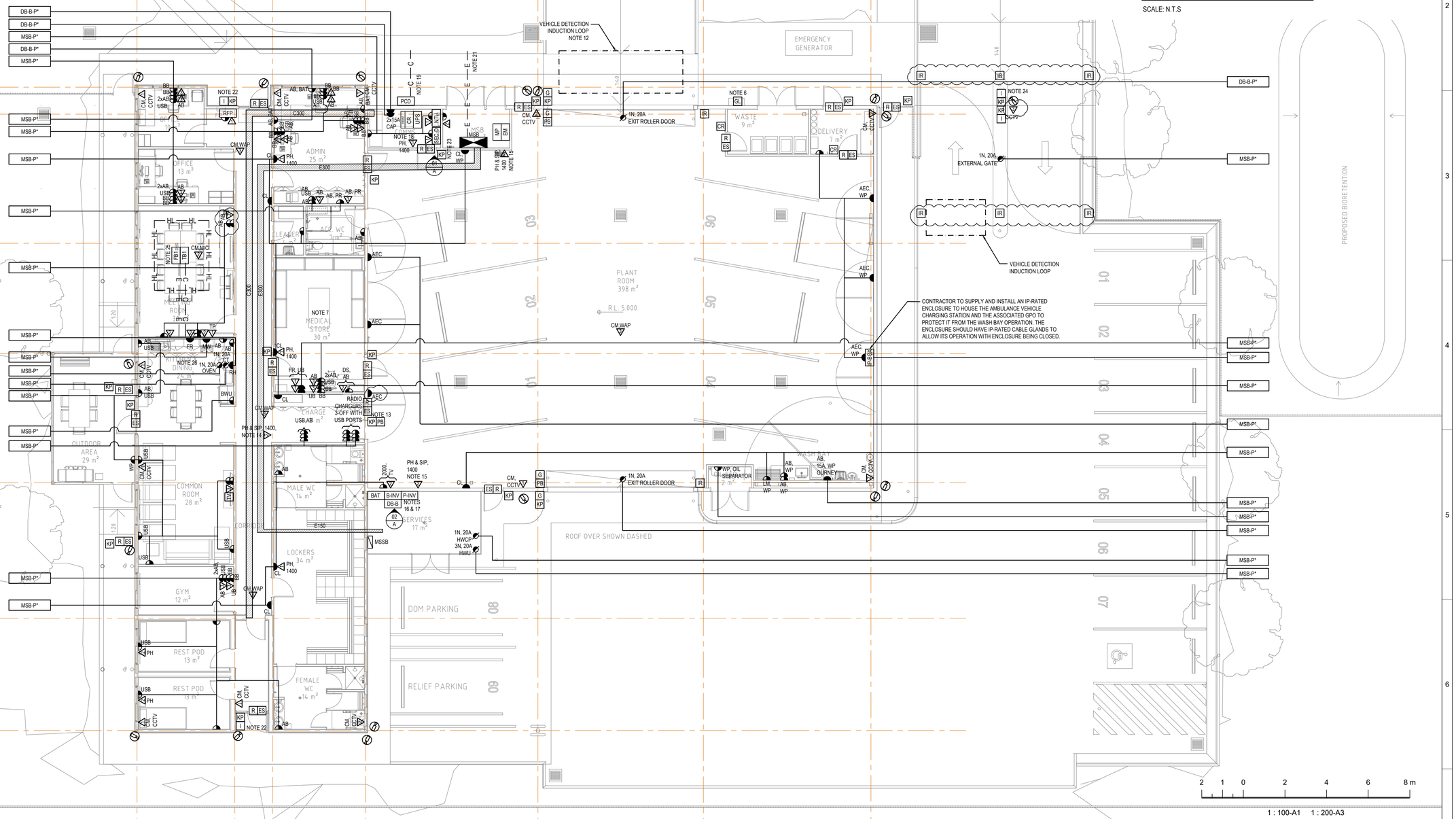
02-A - PV & BATTERY STORAGE ELEVATION

SCALE: N.T.S



01-A COMMS ROOM SECTION

SCALE: N.T.S



1 : 100-A1 1 : 200-A3

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A	05.08.22	TENDER ISSUE	J.G.
1	30.09.22	CONTRACT SET ISSUE	J.G.
2	17.11.22	REVISED CONTRACT SET	J.G.

REVISIONS / AMENDMENTS			
Rev	Date	Description	Verified

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Rural Ambulance Infrastructure Reconfiguration
Building the future response for our state

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PROJECT
RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW

TITLE
ELECTRICAL SERVICES
GROUND FLOOR
POWER AND COMMUNICATIONS
LAYOUT

CONSTRUCTION ISSUE

DRAWN	S.H.	SCALE @ A1
CHECKED	A.B.	1:100
APPROVED	J.G.	
CREATED	MAY 2022	
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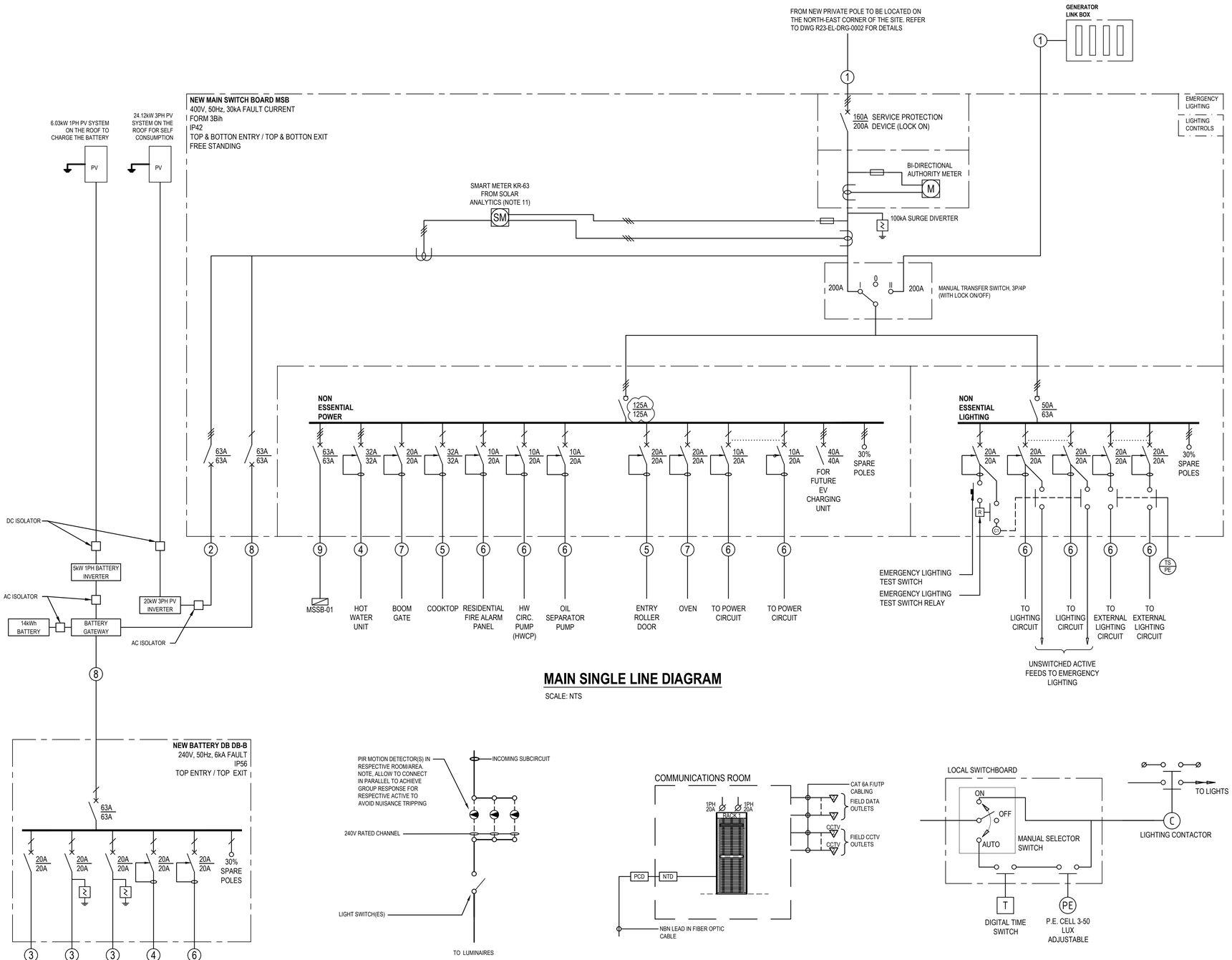
DRAWING No. **R23-EL-DRG-0200**
REV **2**



MAIN SINGLE LINE DIAGRAM

SCALE: NTS

NOTES:

1. ENSURE THE SWITCHBOARDS ARE SIZED TO FIT THE CUPBOARD SPACE PROVIDED ON SITE. THE CONTRACTOR MUST MEASURE EXACT DIMENSIONS ON SITE PRIOR TO DEVELOPMENT OF SHOP DRAWINGS. THE CONTRACTOR WILL NEED TO CONFIRM IN WRITING AND DEVELOP SHOP DRAWINGS FOR REVIEW PRIOR TO MANUFACTURING.
2. REFER TO THE ELECTRICAL SPECIFICATION FOR FURTHER DETAILS. THE CONTRACTOR MUST ENSURE TO SUBMIT SHOP DRAWINGS TO THE AUTHORITIES PRIOR TO SUBMITTING FOR CONSULTANT APPROVAL.
3. ALL WORKS SHALL BE IN ACCORDANCE WITH AS/NSZ 3000:2018 AND NSW SERVICE AND INSTALLATION RULES.
4. DEDICATED SWITCHBOARD CUPBOARDS ARE TO HAVE "NOT TO BE USED FOR STORAGE" SIGN READILY DISPLAYED.
5. ELECTRICAL CONTRACTOR TO ENSURE ALL CIRCUIT BREAKERS DISCRIMINATES WITH ALL UPSTREAM PROTECTION DEVICES.
6. PROVIDE "AS INSTALLED" SITE RETICULATION DIAGRAM (A3 SIZE) LAMINATED SHEET WITHIN MSB ROOM AND WITHIN EACH MDB CUPBOARD.
7. SEE SPECIFICATION FOR DETAILS FOR INDIVIDUAL CIRCUITS SURGE PROTECTION REQUIREMENT. REFER ALSO TO DRAWINGS FOR RELATED CIRCUITS WHICH REQUIRE SURGE PROTECTION.
8. SUPPLY INDIVIDUAL SURGE PROTECTION TO FINAL SUB-CIRCUITS AS INDICATED ON THE ELECTRICAL SPECIFICATION (DISTRIBUTION BOARDS SECTION).
9. CABLES FOR 20A LIGHTING/POWER SUB-CIRCUIT SHALL BE MINIMUM 1x2c x 2.5mm² Cu PVC + E. ALLOW FOR DEDICATED RCD FOR EACH CIRCUIT TO AS 3000 REQUIREMENTS.
10. PV AND BATTERY STORAGE SYSTEM IS BASED ON THE 20kW 3PH PV INVERTER, 5kW 1PH PV HYBRID INVERTER AND 14kWh TESLA POWERWALL 2 BATTERY EQUIPMENT AS PART OF A SINGLE SOLUTION. A DEVIATION FROM THIS APPROACH WILL REQUIRE A RE-DESIGN BY THE CONTRACTOR OF THE SYSTEM SHOWN AND IT SHOULD BE PRESENTED TO THE PRINCIPAL AND JHA FOR REVIEW AND APPROVAL. REFER TO DWGs R23-EL-DRG-0002, R23-EL-DRG-0200 & JHA SPECIFICATION FOR DETAILS. BATTERY TO BE CONFIGURED TO BACK-UP THE FOLLOWING LOADS:
    - EXIT ROLLER DOOR WITHIN THE AMBULANCE PLANT ROOM
    - 2x20A GPO FOR POWER SUPPLY THE COMMS RACKS
    - 1x10A POWER SUB-CIRCUIT TO SERVE 3xDGPOs IN THE ADMIN AREA
    - 2xF3 & 4xF1 LIGHT FITTINGS WITHIN THE ADMIN AREA AND COMMS ROOM
11. CONTRACTOR TO SUPPLY AND INSTALL THE SMART METER KR-63 WITH 4G MODEM MODULE FROM SOLAR ANALYTICS AND THE ASSOCIATED AND COMPATIBLE CT'S FOR THIS CONFIGURATION. CONTRACTOR SHALL PAY FOR A 5-YEAR SUBSCRIPTION FEE FOR SOLAR ANALYTICS MONITORING SERVICE. THE DEVICE SHALL BE CONFIGURED TO MONITOR THE TOTAL ENERGY CONSUMPTION OF THE SITE AND MONITOR THE AC OUTPUT OF THE INVERTERS. CONTRACTOR SHALL ENSURE THAT THE SYSTEM IS COMMISSIONED, TESTED AND THE DATA IS DISPLAYING CORRECTLY. REFER TO JHA SPECIFICATION FOR DETAILS.

CABLE No.	CABLE DESCRIPTION
1	4 x 1c x 50mm² Cu + EARTH XLPE/PVC
2	1 x 4c x 25mm² Cu + EARTH Cu XLPE/PVC
3	1 x 2c x 10mm² + EARTH Cu XLPE/PVC
4	1 x 4c x 4mm² + EARTH Cu XLPE/PVC
5	1 x 2c x 6mm² Cu + EARTH XLPE/PVC
6	1 x 2c x 2.5mm² + EARTH Cu XLPE/PVC
7	1 x 2c x 4mm² + EARTH Cu XLPE/PVC
8	1 x 2c x 25mm² + EARTH Cu XLPE/PVC
9	1 x 4c x 16mm² + EARTH Cu XLPE/PVC

CABLE SCHEDULE

CONTROL CIRCUIT FOR LUMINAIRES CONTROLLED BY MOTION DETECTOR

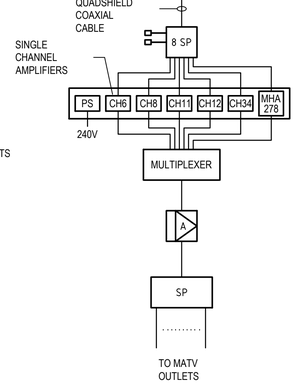
SCALE: N.T.S.

TYPICAL COMMUNICATIONS DIAGRAM

SCALE: N.T.S.

EXTERNAL LIGHTING TIME SWITCH / PE CELL CONTROL SCHEMATIC

SCALE: N.T.S.



TYPICAL MATV DIAGRAM

SCALE: N.T.S.

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1	30.09.22	CONTRACT SET ISSUE	J.G.
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REVISIONS / AMENDMENTS			
Rev	Date	Description	Verified

BUILDER: RAIR — Rural Ambulance Infrastructure Reconfiguration — Building the future response for our state

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CLIENT: NSW GOVERNMENT Health Infrastructure — NSW Ambulance

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PROJECT: **RURAL AMBULANCE RECONFIGURATION INFRASTRUCTURE PROGRAM (RAIR) FAIRY MEADOW**

TITLE: **ELECTRICAL SERVICES** ELECTRICAL SCHEMATICS

CONSTRUCTION ISSUE

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CREATED	MAY 2022	
JOB No.	210067	
DRAWING No.	R23-EL-DRG-0300	REV 2

ENGINEERING SPECIFICATION FOR MECHANICAL SERVICES

RAIR – FAIRY MEADOW

ISSUE	COMMENT	DATE	AUTHOR	CHECKED	AUTHORISED	JOB NO.
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1	CONTRACT SET ISSUE	30/09/22	N.P.	R.A.	R.A.	210067

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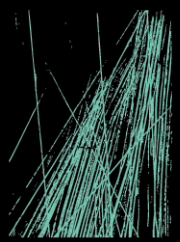

JHA

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TABLE OF CONTENTS

SECTION 1 - SCOPE OF WORKS AND GENERAL REQUIREMENTS

1.1 CONDITION OF CONTRACT - GENERAL

Refer to the contract preliminaries prepared by the Client's representative for general condition of tendering and contract.

1.1.1 GENERAL DESIGN REQUIREMENTS

This project is carried out under a design and construct contract. It is the mechanical contractor's responsibility to carry out the full design of the mechanical services to the minimum requirements stipulated within this specification and accompanying drawings.

The requirements of this document are intended to outline the design requirements, to ensure compliance with all relevant statutory authorities and to ensure that the most cost effective and energy efficient solutions are achieved for the proposed project.

Where deviations from initial design intent are put forward by the Mechanical Contractor, the Mechanical Contractor shall perform calculations, tabulate results and provide qualitatively descriptive reports to confirm design intent and compliance of all design objectives and performance criteria requirements described here-in and on the associated drawings. Provide as a minimum type written and formatted calculations, tabulated results and qualitative description, provide all other manufacturer data and supporting data and literature showing derivations of calculations, for assessment prior to any approval.

1.2 ROLES, OBJECTIVES & EXPECTATIONS

1.2.1 SPECIFICATION OBJECTIVES

a) The intent of this Specification and the associated documents is:-

I. To provide a basis for competitive tendering.

II. To allow competent Contractors to price the works.

III. To provide a clear statement of technical and performance requirements against which compliance can be assessed.

IV. To provide documentation required by Authorities to demonstrate design compliance with statutory requirements.

V. To provide documentation to demonstrate to the Client the scope and quality of the project.

VI. To define the expectations upon the installer, by the Consulting Engineer.

VII. To define the roles of the parties involved with the works.

VIII. To enable other interested parties to assess their obligations and to understand expectations of them.

IX. To define the requirements of the installer with respect to Quality Assurance.

1.2.2 OBLIGATIONS OF THE INSTALLER

b) In writing this Specification the Client expects and relies upon the installer possessing specialist trade expertise necessary to complete the works in accordance with documentation.

c) In addition, the installer has the following obligations:

X. To raise in good time, issues requiring design input or clarification from the Consulting Engineer, particularly in respect to: -

- Interpretation and co-ordination of the Specification or drawings
- Problems in complying with the Specification
- Omissions from the tender documents

XI. To allow the design verification costs of the Consulting Engineer when suggesting alternatives and departures from the Specification.

XII. To certify compliance with Contract documents, including all variation instructions, at Practical Completion.

XIII. To certify compliance with Authority requirements.

XIV. To pay all fees applicable to the works.

XV. To obtain all Authority permits and certificates to allow the progress of the work.

XVI. To provide manufacturer's and construction drawings.

XVII. To provide samples and prototypes where specified.

1.3 INSTALLERS DETAILED DESIGN COORDINATION RESPONSIBILITIES

The installer shall be responsible for ensuring that the detailed design and co-ordination, which is undertaken, is fully co-ordinated and compatible with the remainder of the project design.

The Installers design obligation shall include:

a) Interface details with existing building services

b) Interface details with other trades

c) Size and location of penetrations in walls, floors and structural elements

d) Physical co-ordination of installation with other trades

e) Co-ordination of the construction of the installation

f) Accommodate thermal expansion and construction joint movement in all services, taking into account final installation details and consistency with specified requirements.

g) Equipment mounting details and fasteners.

h) Cable installation details and derating factors.

i) Settings for protection equipment, time delays, time switches etc.

j) Capacity, design and sizing of cable support and conduit systems.

1.4 CONTRACTOR/ SUBCONTRACTOR RESPONSIBILITIES

The sub-contractor is responsible to check the resistances of all ancillary equipment, calculating the system resistances and installing pumps, fans and associated drives with the capacity and power necessary to achieve the specified flow rates against the resistance of the system AS INSTALLED.

Where a system resistance and/or motor size is stated in the Schedule of Equipment, this is given as an approximate guide for TENDERING PURPOSES ONLY and, as such, shall not vitiate the responsibility of the sub-contractor to make all the necessary calculations and supply equipment of adequate capacity and power.

The Subcontractor is to possess specialist trade expertise necessary to complete the works in accordance with the documentation. The Subcontractor has the following additional obligations:

1. To undertake detailed design (refer to design responsibility)

2. To raise in good time, issues requiring design input or clarification, including:

   - Interpretation and co-ordination of the specification and drawings
   - Problems in complying with the specification
   - Omissions from the specification and drawings
   - Suggested alternatives or substitutions

3. To certify compliance with the Contract documents, including all variation instructions, at Practical Completion

4. To certify compliance with Authority requirements;

5. Prepare documentation for Construction Certificate approval, to the requirements of the authority

6. Obtain a copy of the Development Consent conditions for the project and ensure all requirements are met. This includes but is not limited to:

   - Prepare documentation for Construction Certificate approval, to the requirements of the Principal Certifying Authority;

7. Noise associated with mechanical plant must be within the limits nominated in Acoustic report prepared specifically for this site.

8. Approved design roof-top plant. All roof top plant and associated equipment must be located within the approved building envelope.

9. Utility services: Carry out survey of all utility services within and adjacent to the site.

10. To pay all fees applicable to the works

11. To obtain all Authority permits and certificates to allow the progress of the work

12. To provide manufacturer's and construction drawings

13. Provide design certification and installation certification in accordance with the requirements of the PCA (Principal Certifying Authority).

14. To provide samples and prototypes where specified

1.5 PRE-TENDER SITE INSPECTION

The submission of a tender is irrefutable evidence that the tenderer has inspected the site, studied the plans and read the specifications and the relevant contract documents. No allowance in the form of variations or compensation shall be allowed for, by cause of error on the part of the tenderer or his failure to have made such inspection prior to the date of the submission of the tender.

1.6 PROJECT AND BUILDING DESCRIPTION

The project consists of the construction of a new single storey ambulance station located in Fairy Meadow, NSW. The building will consist of a combination of offices, change rooms, WC/Showers, Comms, Gym, Meals, Lounge, sleeping pods, medical store and plant area (accommodating ambulance vehicle parking).

The mechanical systems will include VRV heat recovery air conditioning systems to serve staff areas consisting of a combination of ceiling cassettes and ducted units and dedicated split air conditioning to comms room. Ventilation provision will include for ducted outside air and exhaust systems to serve different areas. Both intakes and exhausts will be located on the external facade of the building. The plant area will be naturally ventilated through the use of permanent natural ventilation openings and roof mounted ventilators.

1.7 SCOPE OF WORK

NOTE: A conforming tender shall be based on the nominated equipment brand. Any alternative shall be costed and submitted as a non-conforming tender price for the client representative consideration.

The works shall include the supply, delivery, installation, testing, commissioning, setting to work, warranty, defect liability and maintenance of the mechanical services and systems including, but not limited to, samples, shop drawings, cable sizing, finishes, painting, identification, as built drawings, comprehensive operation and maintenance manuals, training, spare parts, water treatment, cleaning and system integration as specified herein and the accompanying drawings as follows:

1. Carry out detail design of the mechanical services (D&C). Production of design must include; but not be limited to, heat load calculations, duct sizing, pipework sizing, essential services design, ventilation design, equipment sizing/selection, maintenance access requirements to each piece of equipment/filter/damper/fire damper, shop drawings and coordination with other services and keeping services within architects nominated ceiling heights and bulkheads.

2. Attendance on design and co-orientation meetings.

3. Provide new toilet exhaust ventilation systems comprising but not limited to duct mounted fans, louvres, ductwork, flexible ductwork, ceiling mounted grilles, non-return dampers as per BCA Section J and all wiring and controls for the proper operation of the system.

4. Provide a new Cleaners Room exhaust ventilation system comprising but not limited to duct mounted fans, louvres, ductwork, flexible ductwork, ceiling mounted grilles, non-return dampers as per BCA Section J and all wiring and controls for the proper operation of the system.

5. Ambulance Plant room to be naturally ventilated via fully louvered openings & perforated roller doors. Provide new roof mounted ventilators to plant area complete with electrical operable dampers, control panel located in Admin and associated wiring.

6. Delivery room, MSB, Waste Room and Oil Separator to be naturally ventilated via fully louvered door.

7. Provide new outside air system to serve A/C Cassette units and ducted fan coil units, comprising supply fan, VSD's, louvre, panel filters, plenum box, fire damper supply ductwork and connections to FCU's. Provide all necessary controls and sensors for the proper operation of the system.

8. Provide new kitchen mechanical exhaust system over cooking bench incorporating ductwork and all necessary power and controls. The hood (by others) should be completed with built-in exhaust fan systems that have enough static pressure to discharge the exhaust air to building facade.

9. Provide new VRV Heat recovery air conditioning systems including but not limited to, ceiling mounted cassettes for the small office spaces, Gym and Medical Store; ceiling ducted fan coil units for Admin, Meals and Lounge area and locker rooms with

associated ductwork and connections, refrigerant pipework, drainage, filters, insulation, room thermostats, outdoor condensers (located in services area) and wired remote controller.

Provide new centralised controller (refer to Controls Section) locate in the Admin office.

All units to be provided with factory applied corrosion resistant treatment (Blygold or equivalent)

10. Provide new VRV/VRF Heat Pump IVs system to the sleeping pods including but not limited to, ceiling cassette units, associated connections, refrigerant pipe work, branch selector boxes, condensate drainage, room thermostats, and outdoor condenser unit to be installed within the services enclosure. Condenser units to be provided with anti-vibration mounts.

    Allow to provide side discharge condenser bracketing to double stack comms room and sleeping pods condenser.

    All units to be provided with factory applied corrosion resistant treatment (Blygold or equivalent)

11. Provide split wall mounted air conditioning unit to new Comms room (cooling only), including but not limited to, wall mounted unit, refrigerant pipework, condensate drainage, condensate pump (where required), insulation, wired remote controller, outdoor condenser.

    Allow to provide side discharge condenser bracketing to double stack comms room and sleeping pod condenser.

    All units to be provided with factory applied corrosion resistant treatment (Blygold or equivalent)

12. Provide Time Switches in accordance with BCA as necessary.

13. All sheetmetal and ductwork for air conditioning and ventilation systems including all fittings such as volume controls, access panels, flexible connections, flashings, gaskets to form a complete air distribution system.

14. Provide all fire dampers in ductwork as required in compliance with the NCC requirements.

15. All air diffusers, grilles, registers, door grilles and accessories.

16. Thermal insulation for ductwork.

17. Acoustic lining for ductwork and sound attenuators.

18. Provide vibration isolation equipment, including inertia bases.

19. Provide Seismic restraint components and certification

20. Supply and installation of pipe sleeves and holding down bolts as required.

21. Provide drain, overflow and bleed piping from equipment as required.

22. Framing up and chasing in walls and floors for pipes, cables and all other components, as necessary, and making good afterwards.

23. Penetrations and cutouts in new structures, and fire stopping and making good afterwards.

24. Provision of bird wire mesh to all ducted roof discharges and air intakes without louvres.

25. Concrete plinths for mechanical plant.

26. Overflashing of all penetrations through the roof.

27. All electrical equipment and services required for the operation of the air conditioning and ventilation systems including:

    a. Free standing motor control weather proof switchboard in the services area.

    b. All circuit breakers, fuses, starters, relays, switches, timers, pilot lights, and isolating switches required for the satisfactory operation and maintenance of the systems.

    c. Final connection of 415/3/50Hz four-wire incoming power submains onto each Mechanical switchboard (MSSB) including supply and connection of terminating lugs.

    d. All power wiring between the switchboards and motors, starters, and ancillary equipment including terminating lugs and final connections.

    e. All control and interlocking wiring required to form a complete and operating control system as described under "Automatic Controls".

    f. Controls and associated equipment for the automatic regulation of the systems as specified under "Automatic Controls".

28. All lifting, lowering, handling and associated scaffolding for all equipment covered in this specification.

29. Provide framing up and chasing in walls and floors for pipes, cables and all other components, as necessary, and making good afterwards.

30. Undertaking and providing all lifting, lowering, handling and associated scaffolding for all equipment covered in this specification.

31. Painting and identification of installation as specified.

32. Commissioning, testing and demonstrating the performance of all systems installed.

33. Progressive pressure testing of ductwork and the issuance of testing results to the client representative

34. Instruction of maintenance personnel in the operation of all building services.

35. Provision of Shop Drawings and As Installed drawings, including permanent reduced scale diagrams as specified.

36. Provision of Instruction Manuals.

37. Maintenance during 12 months defects liability period.

1.8 WORKS BY AND WITH OTHER WORKS PACKAGES

The mechanical sub-contractor must supply sufficient drawings or details, at their cost, to enable these various works to be carried out, and provide details in ample time for those works to be carried out during the normal progress of the work and/or in accordance with the programme for the main contract works.

1.8.1 BY MAIN CONTRACTOR

1. The provision and making good including fire rating around all openings in the building structure for the penetration of pipes, ducts, grilles and conduits and all cutting, patching, framing up, furring in and making good associated with the building structure, including chases.

2. The provision of trimmed openings in roof for ducts and pipes complete with underflashings.

3. The provision of trimmed openings in walls, ceilings and doors for diffusers, louvres and grilles.

4. Concrete plinths for mechanical plant.

5. The supply and installation of external louvres, sizes of which to be confirmed by this mechanical contractor.

6. Installation of all door grilles.

7. Supply and Installation of domestic kitchen range hood

1.8.2 BY ELECTRICAL WORKS PACKAGE

1. The provision of 415V/3/50Hz four-wire power mains or diesel power supply to the incoming connections of the motor control switchboards including tails in the plant rooms for permanent connection by this mechanical contractor.

2. Provision of data outlet adjacent to the centralised controllers.

3. The provision of fire trip to the MSSB, final connection to the MSSB by mechanical.

1.8.3 BY HYDRAULICS WORKS PACKAGE

1. The provision of tundishes & floor drains indicated on the drawings as required by standards and regulations for the mechanical plant.

1.9 INFORMATION TO BE PROVIDED THE MECHANICAL WORKS PACKAGE

Provide detailed dimensioned drawings to the main contractor and other interested parties in ample time for accurate positioning of:

1. All openings.

2. All pipe sleeves.

3. All holding-down bolts.

4. All other anchorage and/or fixings required.

5. All required external louvres.

6. All permanent access openings in ceiling and walls for adjustment and maintenance of equipment.

7. All air diffusers, registers, grilles and louvres.

8. All floor wastes.

9. All plinths, kerbs and bases.

1.10 DESIGN DRAWINGS

The Design Drawings show the position of equipment and layouts throughout the building. These shall be considered as diagrammatic only unless specifically dimensioned relative to other building elements. These drawings shall be read in conjunction with the relevant written clauses in this specification.

The Design Drawings are listed below and form part of this specification:

R23-ME-0000 *Cover Sheet and Drawing List*

R23-ME-0001 *Legend of Symbols and General Notes*

R23-ME-0100 *Ground Floor Air Conditioning and Ventilation Layout*

R23-ME-0101 *Roof Air Conditioning and Ventilation Layout*

1.11 GENERAL REQUIREMENTS

1.11.1 RESPONSIBILITIES

1.11.1.1 Design - General

The specification and drawings are intended to represent the nature of the works to be undertaken. The installer is responsible for the provision of all aspects of the mechanical services in order to provide a complete and functioning system which matches the brief. The brief is defined by a combination of documents which include:

- This specification and drawings, including operational performance requirements;
- Architectural documentation (prepared by others)
- Other referenced information which can include fire engineering briefs, acoustic reports, services brief or other client supplied items.

Fully qualified Engineers, with appropriate and relevant experience in the design of Heating Ventilation and Air conditioning Systems for equivalent projects shall undertake the design.

All calculations shall be made using industry standards, codes and guides which include:

- Documentation published by AIRAH, ASHRAE, CIBSE and Australian Standards,

Calculations shall be made available for submission on request by the superintendent to clarify any particular aspect of the design development.

Low energy and low maintenance systems and designs shall be targeted, where possible and where meets the performance brief.

The installer shall allow to be available to attend design meetings to develop the coordination with other trades, up until such time that the design is approved.

Where the contractor provides design, use only appropriately qualified persons and conform to all statutory requirements.

If it is believed that a conflict exists between statutory requirements and the documents, notify the contract administrator immediately and provide a recommendation to resolve the conflict.

1.11.1.2 Design - specifics

Further to those requirements identified above the contractor / installer is responsible for, but not limited to:

- Determination of and coordination of all penetrations through building elements.
- Provision of advice to other trades affected by mechanical services equipment, including information such as heat rejected from equipment, ventilation discharge impacts, electrical loading for power supply finalisation, water pressure and gas pressure requirements for supplies.
- Accommodate thermal expansion and construction joint movement in the design and installation of all services.
- Installation details of pipework, pipework supporting systems, cable trays and the like.
- Settings for electrical protection equipment, including time delays, time switches, balancing flows, flow regulating valves, dampers and the like.
- Preparation of detailed design development, construction issue and workshop drawings.
- Finalisation of coordinated reticulation routes and detailed coordination of services in ceilings, risers, shafts and plantrooms.
- Determination and calculation of all system pressure drops for fans, pumps etc such as to determine final equipment selections.
- Selection of all valves.
- Detailed design of all electrical systems including motor control centres, switchgear, cable pathways, cabling type and sizes, fire rating segregation and fire rated cabling, discrimination etc.
- Detailed design of all automation systems.
- Design of fixings, brackets and the like for the support of mechanical services equipment.
- Selection of air grilles, door louvers, registers and the like. Selections shall be made based on full consideration of air flow performance, minimisation of draft and appropriate noise levels.
- Design of all fire rating to mechanical services equipment, including coordination of provision of fire rated bulkheads with the builder or main contractor.

- Selection of all equipment. Equipment shall be suitable to meet performance requirements at all reasonable and normal operating conditions when put into service.

- Coordination with the building trades in relation to acoustic treatment of the mechanical services.

- Coordination of interfaces for all trades. The contractor shall allow to coordinate and resolve interfaces whether or not these are explicitly defined in the tender documentation. The contractor shall confirm and coordinate their allowances for interfaces at tender stage also such that all aspects of the services required for a complete and functioning system are fully included in the tender. Examples of such interfaces include, but are not limited to:

    - Mechanical services Interfaces to occupancy sensors (PIR) or other automated control or security system;

    - Interfaces to smoke detection and smoke control equipment during fire, including Fire fan control panels and FIP

    - Electrical power to mechanical equipment

    - Access ladders, gantries, steps, platforms and the like to enable safe access to mechanical services equipment;

1.11.1.3 Coordination

The contractor is responsible for all final detailed coordination. The tender drawings do not show all incidental set-ups or set-downs, transitions, bends etc needed to coordinate with all structure and other services. The contractor shall allow to finalise this and participate in coordination with other trades and structure in the preparation of design development and workshop drawings.

1.11.1.4 Existing services

No warranty is given as to the completeness or accuracy of drawings and/or manuals of existing services.

1.11.1.5 Noise levels

Install systems in conformance with the Acoustic Consultant Report and within the limits of the contract design, documented equipment performance, and AS/NZS 2107.

1.11.1.6 Structural performance

If required, provide structures, installations and components as follows:

- Fixed access ways: To AS 1657.

- Structural design actions: To AS/NZS 1170.0 and the **Structural design actions schedule**.

1.11.1.7 Precedence

Where discrepancies exist between the drawings and the specification, the most onerous shall be allowed for in the tender.

1.11.2 REFERENCED DOCUMENTS

1.11.2.1 Contractual relationships

Responsibilities and duties of the principal, contractor and contract administrator are not altered by requirements in the documents referenced in this specification.

1.11.2.2 Current editions

Use referenced documents which are the editions, with amendments, current 3 months before the closing date for tenders, except where other editions or amendments are required by statutory authorities.

1.11.3 STANDARDS, CODES AND AUTHORITIES

All works shall be in compliance with national and local Statutory Authorities and in compliance with the following:

1. Building Code of Australia (BCA) and Building Permit conditions
2. WorkCover requirements
3. OH&S Regulations
4. Electricity supply Authority
5. Fire Brigade requirements
6. Local Council regulations
7. AS 1668.1 - Fire and Smoke Control in Buildings.
8. AS 1668.2 - Mechanical Ventilation in Buildings.
9. AS/NZS 3666.1 - Air handling and water systems of buildings - Microbial Control.
10. AS3000 and AS3008 – Wiring Rules.
11. EMC to AS/NZS 61000.
12. Water supply, sanitary plumbing and drainage to AS/NZS 3500
13. Australian Communications Authority (ACA)

1.11.4 CONTRACT DOCUMENTS

Layouts of service lines, plant and equipment shown on the drawings are diagrammatic only, except where figured dimensions are provided or calculable.

Before commencing work:

1. Take necessary measurements and seek other necessary information.
2. Coordinate the design and installation in conjunction with all trades.

1.11.5 INSPECTION

1.11.5.1 Notice

If notice of inspection is required in respect of parts of the works that are to be concealed, advise when the inspection can be made before concealment.

Minimum notice for inspections to be made: 10 days

Light level requirements: to AS/NZS 1680.2.4.

1.11.5.2 Tests

Give notice of the time and place of nominated tests.

Minimum notice for witnessing of tests: 10 days

1.11.5.3 Attendance

Provide attendance for documented inspections and tests.

1.11.6 SUBMISSIONS

1.11.6.1 General

Submit to the Client's Representative

Make submissions at least 5 working days before ordering products for, or starting installation of, the respective portion of the works.

Allow in the construction program for at least the following times for response to submissions:

1. Shop drawings: 5 days
2. Samples and prototypes: 5 days
3. Manufacturers' or suppliers' recommendations: 5 days
4. Product data: 5 days
5. Product/design substitution or modification: 5 days

If major products are not specified as proprietary items, submit a schedule of those proposed for use within 3 weeks of site possession.

1.11.6.2 Authorities

Submit documents showing approval by the authorities whose requirements apply to the work.

Submit copies of correspondence and notes of meetings with authorities whose requirements apply to the work.

1.11.6.3 Building penetrations

If it is proposed to penetrate or fix to the following, submit details of the methods proposed to maintain the required structural, fire and other properties:

1. Structural building elements including external walls, fire walls, fire doors and access panels, other tested and rated assemblies or elements, floor slabs and beams.
2. Membrane elements including damp-proof courses, waterproofing membranes and roof coverings. If penetrating membranes, provide a waterproof seal between the membrane and the penetrating component.

1.11.6.4 Certification

Submit certification that the plant and equipment submitted meets all requirements of the contract documents.

1.11.6.5 Electrical loading information for mechanical services

Submit electrical loading information for all equipment before completion of the main switchboard shop drawings.

Loading and connection: Submit the information for items not supplied from the services switchboards.

Starting characteristics: Submit details for motors with reduced current starting. Ensure starting characteristics are within the characteristics of the respective submain protection devices.

Switchboards: Submit the following information for each building services switchboard:

1. Board location and designation.

2. For each submain connected to the board, submit the following for each item connected to it:

    a) Submain designation.

    b) Item designation and name.

    c) Power rating in kW.

    d) Number of phases.

    e) Full load amps per phase.

    f) Power factor.

    g) Total amps on each phase for respective sub main.

1.11.6.6 Errors

If a submission contains errors, make a new or amended submission as appropriate, indicating changes made since the previous submission.

1.11.6.7 Execution details

Before starting the respective portions of the installation, submit the following:

1. Proposed method for embedding services in concrete walls or floors or chasing into concrete or masonry walls.

2. Typical details of locations, types and methods of fixing of services to structure.

3. If services will be enclosed and not accessible after completion, submit proposals for location of service runs and fittings.

1.11.6.8 Identification

Identify the project, contractor, subcontractor or supplier, manufacturer, applicable product, model number and options, as appropriate and include pertinent contract document references. Include service connection requirements and product certification. Identify proposals for non-compliance with project requirements, and characteristics which may be detrimental to successful performance of the completed work.

1.11.6.9 Inspection and testing plan

Submit an inspection and testing plan which is consistent with the construction program. Include particulars of test stages and procedures.

Submit written reports on nominated tests.

1.11.6.10 Marking and labelling

Before marking and labelling submit the following:

1. Samples of the proposed labels.
2. A schedule showing, for each item or type of item:
    a. A description of the item or type of item sufficient to identify it.
    b. The proposed text of the marking or label
    c. The proposed location of the marking or label.

1.11.6.11 Materials and components

If products must conform to product certification schemes, submit evidence of conformance.

For proprietary equipment, submit the manufacturer's product data as follows:

1. Technical specifications and drawings.
2. Type-test reports.
3. Performance and rating tables.
4. Recommendations for installation and maintenance.
5. Additional product data for services equipment:
    a. Model name, designation and number.
    b. Country of origin and manufacture.
    c. Capacity of all system elements.
    d. Size, including required clearances for installation.
    e. Materials used in the construction.

1.11.6.12 Substitution

Identification of a proprietary item does not necessarily imply exclusive preference for the item so identified, but indicates the necessary properties of the item.

If alternatives to the documented products, methods or systems are proposed, submit sufficient information to permit evaluation of the proposed alternatives, including the following:

1. Evidence that the performance is equal to or greater than that specified.
2. Evidence of conformity to a cited standard.
3. Samples.
4. Essential technical information, in English.
5. Reasons for the proposed substitutions.
6. Statement of the extent of revisions to the contract documents.

7. Statement of the extent of revisions to the construction program.

8. Statement of cost implications including costs outside the contract.

9. Statement of consequent alterations to other parts of the works.

If the documented products or systems are unavailable within the time constraints of the construction program, submit evidence.

If the substitution is for any reason other than unavailability, submit evidence that the substitution:

1. Is of net enhanced value to the principal.

2. Is consistent with the contract documents and is as effectual as the identified item, detail or method.

1.11.6.13 Samples

Submit nominated samples.

If it is intended to incorporate samples into the works, submit proposals. Incorporate samples in the works which have been endorsed for inclusion. Do not incorporate other samples.

Keep endorsed samples in good condition on site, until the date of practical completion.

1.11.6.14 Shop drawings

Include dimensioned drawings showing details of the fabrication and installation of structural elements, building components, services and equipment, including relationship to building structure and other services, cable type and size, and marking details.

Coordinate work shown diagrammatically in the contract documents, and submit dimensioned set-out drawings.

Ensure that the drawings have been checked before submission.

1.11.6.15 Building services shop drawings

General: Minimum A1 drawing size.

Standard: To AS 1100.101, AS 1100.201, AS 1100.301, AS 1100.401 and AS/NZS 1100.501 as applicable.

Submit the following:

1. Detailed drawings, at 1:50 scale or larger, showing:

2. Fire and smoke dampers including dimensional tolerances.

3. Floor wastes.

4. Ductwork, pipework and equipment layouts and sections. Show the location of fire rated building elements.

5. For refrigerant piping include slope of horizontal runs, oil traps, double risers and valving.

6. Diffuser and grille reference numbers corresponding to commissioning test results.

7. Riser layouts and sections.

8. Plant room layouts and sections.

9. Locations of automatic control sensors, motors and valves.

10. Acoustic details.

11. Conditioner construction details.

12. Seismic restraint details.

13. Relevant performance data for each item of equipment including make, model, speed, capacity etc., as appropriate.

14. Piping and other schematic drawings including numbering of each valve to correspond to the valve tag notation.

15. Submission drawings required by authorities.

16. Automatic control details.

17. Switchboard details.

18. Wiring diagrams.

Coordinate with other building and service elements. Show adjusted positions on the shop and record drawings.

Check space requirements of equipment and services indicated diagrammatically in the contract documents.

1.11.6.16 Building services technical data

Take note that documented fan pressures and pump heads are based on provisional equipment selections and estimated pressure drops.

Before ordering equipment, calculate the respective system pressure losses based on the equipment offered and layouts shown on the shop drawings and submit the proposed selections.

Submit technical data for all items of plant and equipment.

Include at least the following information in technical submissions:

1. Assumptions.

2. Calculations.

3. Model name, designation and number.

4. Capacity of all system elements.

5. Country of origin and manufacture.

6. Materials used in the construction.

7. Size, including required clearances for installation.

8. Certification of compliance with the applicable code or standard.

9. Technical data schedules corresponding to the equipment schedules in the contract documents. If there is a discrepancy between the two, substantiate the change.

10. Manufacturers' technical literature.

11. Type-test reports.

1.12 PRODUCTS

1.12.1 GENERAL

1.12.1.1 Manufacturers' or suppliers' recommendations

Provide and select, if no selection is given, transport, deliver, store, handle, protect, finish, adjust and prepare for use the manufactured items in accordance with the current written recommendations and instructions of the manufacturer or supplier.

Assemble, install or fix to substrate in accordance with the current written recommendations and instructions of the manufacturer or supplier.

Advise of activities that supplement, or are contrary to, manufacturers' or suppliers' written recommendations and instructions.

1.12.1.2 Sealed containers

If materials or products are supplied by the manufacturer in closed or sealed containers or packages, bring the materials or products to point of use in the original containers or packages.

1.12.2 TESTS

Except for site tests, have tests carried out by a Registered testing authority and submit test reports.

Submit copies of test reports, including certificates for type tests, showing the observations and results of tests and conformance or non-conformance with requirements.

Use instruments calibrated by authorities accredited by a Registered testing authority.

1.12.2.1 Materials and components

Consistency

For each material or product use the same manufacturer or source and provide consistent type, size, quality and appearance.

1.13 EXECUTION

1.13.1 OFFSITE DISPOSAL

Dispose of material off site to the requirements of the relevant authorities.

1.13.2 WALL CHASING

If holes and chases are required in masonry walls, provide proposals to demonstrate that the structural integrity of the wall is maintained. Do not chase walls nominated as fire rated or acoustic.

Parallel chases or recesses on opposite faces of a wall shall not be closer than 600 mm to each other.

Chasing of blockwork shall only be in core-filled hollow blocks or in solid blocks which are not designated as structural and with the maximum depth of chase suitable for the block thickness.

1.13.3 FIXING

If equipment and services are not suitable for fixing to non-structural building elements, fix directly to structure and trim around penetrations in non-structural elements.

Use proprietary fasteners capable of transmitting the loads imposed, and sufficient to ensure the rigidity of the assembly.

1.13.4 SERVICES INSTALLATION - GENERAL

Fixing: If non-structural building elements are not suitable for fixing equipment and services to, fix directly to structure and trim around holes or penetrations in non-structural elements.

Installation: Install equipment and services plumb, fix securely and organise reticulated services neatly. Allow for movement in both structure and services.

Concealment: Conceal all cables, ducts, trays, pipes etc. unless installed in plant spaces ceilings, riser cupboards, etc. unless otherwise documented. If possible, do not locate on external walls.

Lifting: Provide heavy items of equipment with permanent fixtures for lifting as recommended by the manufacturer.

Suspended ground floors: Keep all parts of services under suspended ground floors > 150 mm clear of the ground surface. Make sure services do not impede access.

Arrangement: Arrange services so that services running together are parallel with each other and with adjacent building elements.

1.13.5 BUILDING PENETRATIONS

1.13.5.1 Embedded pipes

Do not embed pipes that operate under pressure in concrete or surfacing material.

1.13.5.2 Penetrations

Fire rated building elements: Seal penetrations with a system conforming to AS 4072.1.

Non-fire rated building elements: Seal penetrations around conduits and sleeves. Seal around cables within sleeves. If the building element is acoustically rated, maintain the rating.

1.13.5.3 Sleeves

If piping or conduit penetrates building elements, provide metal or PVC sleeves formed from pipe sections as follows:

1. Arrange to permit normal pipe or conduit movement.
2. Diameter (for non fire-rated building elements): Sufficient to provide an annular space around the pipe or pipe insulation of at least 12 mm.
3. Prime paint ferrous surfaces.
4. Terminations:
    a. If cover plates are fitted: Flush with the finished building surface.

b. In fire-rated and acoustic-rated building elements: 50 mm beyond finished building surface.

c. In floors draining to floor wastes: 50 mm above finished floor.

d. Elsewhere: 5 mm beyond finished building surface.

5. Termite management: To AS 3660.1.

6. Thickness:

a. Metal: ≥ 1 mm.

b. PVC: ≥ 3 mm.

1.13.5.4 Sleeves for cables

For penetrations of cables not enclosed in conduit through ground floor slabs, beams and external walls provide sleeves formed from PVC pipe sections.

1.13.6 SUPPORT AND STRUCTURES

1.13.6.1 General

Provide incidental supports and structures to suit the services.

1.13.6.2 Support of roof mounted plant and equipment

If structural platforms are required, or the area of the plant and equipment is extensive, obtain the advice of a professional engineer for the documentation of a suitable platform.

1.13.6.3 Support of ground level plant and equipment

Provide proprietary concrete supports installed with falls that achieve a raised, impervious and water shedding bearing surface.

1.13.7 PLANT AND EQUIPMENT ACCESS

Locate and arrange all services and equipment so that:

1. They comply with the relevant requirements of the appropriate Occupational Health and Safety regulations.

2. Failure of plant and equipment (including leaks) does not create a hazard for the building occupants.

3. Failure of plant and equipment (including leaks) cause a minimum or no damage to the building, its finishes and contents including water sensitive equipment or finishes.

4. Inspection and maintenance operations can be arranged to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.

5. Safe tray and an overflow pipe are provided to each tank, hot water heater and storage vessel.

6. Services and equipment are readily accessible for inspection and maintenance and arranged so that inspection and maintenance can be carried out in a safe and efficient manner. Conform to the relevant requirements of AS 1470, AS 1657, AS/NZS 1892.1, AS 2865 and AS/NZS 3666.1.

7. If parts of the plant (including high level tanks) require regular inspection and maintenance either locate plant so it is safely and readily accessible from floor level or provide permanent access platforms and ladders.

8. In false ceilings locate items of equipment that require inspection and maintenance above tiled parts where possible. If this is not possible (for example if above set plaster or other inaccessible ceilings) provide access panels. Arrange services and plant locations to reduce the number of access panels. Coordinate with other trades to use common access panels where feasible.

9. Modify manufacturer's standard equipment when necessary to provide the plant access in the contract documents.

1.13.8 VIBRATION SUPPRESSION

1.13.8.1 General

Minimise the transmission of vibration from rotating or reciprocating equipment to other building elements.

1.13.8.2 Connections

Provide flexible connections to rotating machinery and assemblies containing rotating machinery. Isolate pipes by incorporating sufficient flexibility into the pipework or by use of proprietary flexible pipe connections installed so that no stress is placed on pipes due to end reaction.

1.13.8.3 Inertia bases

If necessary to achieve the required level of vibration isolation, provide inertia bases having appropriate mass and conforming as follows:

1. Construction: Steel or steel-framed reinforced concrete. Position foundation bolts for equipment before pouring concrete.

2. Supports: Support on vibration isolation mountings using height saving support brackets.

1.13.8.4 Speeds

If no maximum speed is prescribed do not exceed 1500 r/min for direct driven equipment.

1.13.8.5 Vibration isolation mountings

Except for external equipment that is not connected to the structure of any building, support rotating or reciprocating equipment on mountings as follows:

1. For static deflections < 15 mm: Single or double deflection neoprene in-shear mountings incorporating steel top and base plates and a tapped hole for bolting to equipment.

2. For static deflections ≥ 15 mm: Spring mountings.

Provide mountings selected to achieve 95% isolation efficiency at the normal operating speeds of the equipment.

Set and adjust vibration isolation mounting supports to give clearance for free movement of the supports.

Spring mountings: Provide freestanding laterally stable springs as follows:

1. Clearances: ≥ 12 mm between springs and other members such as bolts and housing.

2. High frequency isolation: 5 mm neoprene acoustic isolation pads between baseplate and support.

3. Levelling: Provide bolts and lock nuts.

4. Minimum travel to solid: ≥ 150% of the designated minimum static deflection.

5. Ratio of mean coil diameter to compressed length at the designated minimum static deflection: ≥ 0.8:1.

6. Snubbing: Snub the springs to prevent bounce at start-up.

7. Vertical resilient limit stops: To prevent spring extension when unloaded, to serve as blocking during erection and which remain out of contact during normal operation.

1.13.9 SEISMIC BRACING/RESTRAINT FOR MECHANICAL SERVICES

1.13.9.1 Regulations/Standards

AS1170.4 Structural Design Action - Earthquake Actions in Australia

All mechanical plant, equipment and supports shall be fixed to the building in accordance with AS1170.4 (including Section 8).

For IL4 buildings (projects with post disaster function), a special study is required to ensure the facility remains 'Serviceable for Immediate Use' post-earthquake and cyclone events (1 in 500 years). Building importance level definition remains the responsibility of the building owner/end-user via a risk assessment mechanism in the NCC.

AS5216 - Post-installed Anchors

All anchors used for seismic bracing shall be rated by the manufacturer for seismic loads

Provisions

Arrange all components, other than service items exempted in AS 1170.4 Clause 8.1.4, to resist seismic loads determined in accordance with AS 1170.4

- Securely fix all mechanical plant and equipment to the building structure. Do not rely on gravity and/or friction to resist seismic forces.
- Where anti vibrations devices (such as spring mountings) are used, they shall be horizontal and vertical restrained type, to inhibit the development of resonance in the flexible mounting system, and to prevent overturning. If these cannot be used equipment to be fixed or restrained separately to the spring mountings.
- Do not use mechanical equipment or components that will be damaged by earthquake conditions. Protect systems against the adverse effects of components such as mercury switches that, although not damaged by earthquake, may malfunction.

1.13.9.2 Seismic Restraint and Expansion/contraction

- General: Seismic restraint shall be in accordance with AS1170.4 and an associated Seismic Engineering Specialist detail drawing.
- Method of fixing floor mounted equipment shall be in accordance with AS1170.4 and an associated Seismic Engineering Specialist detail drawing.

1.13.9.3 Description of Work

- Seismic restraints are designed to limit the movement of equipment and to keep equipment captive during a seismic event.

- Non-compliance with seismic restraint requirement shall be corrected by the contractor in an approved manner.
- The work in this section includes, but is not limited to the following:
    - Seismic restraint for mechanical systems and equipment.
    - Equipment and conduit buried underground is excluded but entry of services through the foundation wall is included.

Typical Mechanical equipment to be restrained is as follows:

- Ductwork
- Pipework
- Cable Distribution
- Fans
- Chillers
- Boilers
- Air Handling Units
- Fan Coil units
- VAV Boxes
- Colling Towers
- Compressors
- Pumps
- Air Separators
- Tanks and Gas Cylinders
- Switchboards
- Generators
- Grill Boxes
- Duct and Pipe Risers

Items not specifically mentioned in AS1170.4 section 8.1.4 are considered to require restraint by "All other components similar to those listed" and may include shelving, items installed in ceiling voids, cranes, building maintenance units, water storage tanks, systems involving hazardous materials, pressure vessels and heat exchangers, solid fuel heaters, water treatment equipment, waste disposal equipment, air handling plant and fans, automatic control systems and BMS, cable trays, ladders, busbars, conduits, plinths, fuel storage systems, batteries and UPS.

- Seismic restraint shall be installed in accordance with AS1170.4. Provide calculations signed by structural engineer licensed in the Australia in which the work is to take place certifying that seismic restraints will act in accordance with the relevant standards stipulated in the specification and will maintain equipment in captive position

1.13.9.4 1.4 Seismic Design Criteria

The following is a list that is needed for seismic engineering and may be obtained from the structural engineer associated with the project.

- Seismic design criteria
    - Building/Structure Importance level (IL#)
    - Earthquake design category (EDC)
    - Hazard Design Factor (Z)
    - Site sub-soil class
    - Probability Factor

1.13.9.5 Provisions

Comply with the following as a minimum:

Arrange all components to resist the design earthquake loads as determined by the use of AS 1170.4-2007.

Restrain all mechanical components against seismic loads including those parts and components identified in Clause 8.1.4, AS 1170.4-2007.

Plant and equipment: Securely fix all mechanical plant and equipment to the building structure. Fixings shall have a load-transferring capacity equal to or more than that determined by the use of AS 1170.4-2007.

Fixings: Fix all mechanical components to withstand earthquake loads determined in accordance with AS 1170.4-2007 Do not rely on gravity and friction to resist seismic forces.

Anti-vibration mounts: Use horizontally restrained type with a load-transferring capacity equal to or in excess of that determined by the use of AS 1170.4-2007. If this is not possible use snubbers or equipment clips to restraint with free springs.

Components: Do not use components that will be damaged by earthquake conditions. Protect systems against the adverse effects of components such as mercury switches which, although not damaged by earthquake, may malfunction.

Submission: Provide evidence that the fixings and vibration isolation installed comply with the requirements of AS 1170.4-2007. Include the provision of a design certificate with calculations certified, by an experienced and practicing structural engineer.

Material submittals shall include, but not limited to the following information:

• Catalogue cuts and data sheets on specific restraints on other equipment to be utilised, showing compliance with the specification.

• A list of the items of equipment to be restraint, the proposed seismic restraint types and models, and seismic restraint loading.

1.13.9.6 Shop Drawings:

- Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations as well as the integration of vibration isolation.

- Where walls, floors, slabs, or supplementary steel work are used for seismic restraint locations; details of acceptable attachment methods must be included and approved before the condition is accepted for installation. Restrain manufacturer's submittals must include spacing, static loads and seismic loads at all attachment and support points.

- Provide specific details of seismic restraints, vibration isolation and anchors; include number, size, and locations for each piece of equipment.

1.13.9.7 Seismic Analysis:

- Seismic restraint calculations must be provided for all connections of equipment to the structure.
- Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilised for connections to equipment and structure.
- Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, acting through the equipment centre of gravity. Overturning moments may exceed forces at ground level.

1.13.9.8 Contractor's Responsibilities

The following is the minimum contractor's responsibility:

- Engage a Seismic Design Specialist to:
    - provide specific engineering design of all seismic/wind restraints.
    - advise appropriate service clearances.
    - perform installation inspections, and
    - provide certification the design requirements have been met.
- Confirm with relevant trades that all walls, ceiling and partitions are engineered for the loads of engineering services elements and ensure that appropriate service clearance requirements have been met.
- Ensure values for all parameters with the Structural Engineer and allow to adjust calculations and equipment selections as required prior to ordering equipment
- *IL4 projects only - engage Seismic Design Specialist to conduct a Special Study as required by AS1170.4.*
- Carry out all remedial works due to failure to meet the above responsibilities at no cost.

1.13.9.9 Document Submittals

Submit the following documentation prior to commencement of work or ordering of equipment

- Design computations for all design items and check as required within this specification including:
- Equipment support seismic computations.
- Seismic restraints design, locations and auditable load calculations
- Adjusted services pathway illustrating minimum service clearances as outlined in specific engineering design and coordination with relevant trades.

1.13.9.10 Inspections and Verification

Prior to installation of ceilings, notice shall be given for inspection by Seismic Design Specialist and main contractor of in-ceiling systems, seismic anchors and seismic restraints.

Seismic Design Specialist to provide a Construction Monitoring Report for submittal for installed restraints and braces.

Failure to give notice will result in cutting and patching of coverings for spot checking. Prior to practical completion, Seismic Design Specialist shall issue certification that installation meets design requirements, signed by qualified structural/seismic engineer.

1.13.9.11 Services Expansion/contraction

Refer to structural drawings for location and details of building expansion joints. Perform, submit, coordinate and provide calculations for all aspects of pipe and duct expansion and contraction including:

- Building expansion joints (movement 75mm in all directions as described)
- Temperature variations across all conditions including construction, operation, building or part building isolation/shutdown under all possible weather conditions
- Anchor locations, forces and construction details. Coordinate with the Managing Contractor and provide all necessary structural support as required.
- Arrange reticulated services and equipment to avoid excessive movement, forces and stress in pipework and ductwork and to eliminate the risk of pipe, duct and equipment connection fractures.

- Provide appropriate lengths of hanger, pipe/duct guides, saddles, rollers, anchors, changes of direction, expansion loops, spring hangers, expansion bellows, etc. as required.
- Acoustic penetrations shall be arranged to allow necessary longitudinal and lateral movement.

Provide design certificate with calculations, certified by an experienced and practicing Structural/Seismic Engineer.

All pipe and duct systems shall accommodate the following building joints expansion:

- Horizontal movement:
- Vertical movement:

1.13.9.12 Services Clearances

- Minimum clearances for services shall apply as per below table
- These clearances include services and other structural and non-structural elements, including but limited to pillars, ceiling hangers, wall studs, etc.
- Such service clearances need to be allowed for in the design, with pathways adjusted, and any changes communicated to other trades and project management.

The following minimum clearances must be achieved:

Condition being considered	Minimum Clearances	
	Horizontal	Vertical
Unrestrained component to unrestrained component	250 mm	50 mm
Unrestrained component to restrained component	150 mm	50 mm
Restrained component to restrained component	50 mm	50 mm
Penetration through structure such as wall or floor	50 mm	50 mm
Restrained services passing through the ceiling	25 mm	25 mm
NOTE: ceiling hangers and braces are considered to be restrained components for the purpose of this table, hence 150 mm horizontal clearance is required between ceiling hangers and unrestrained services		

1.13.9.13 Seismic Testing & Component Importance Factors

The Equipment Schedule indicates the Component Importance Factors (I_p) applicable to equipment and the systems associated.

The Equipment Schedule indicates where equipment/plant shall be capability to maintain its integrity and remain operational in the event of earthquake. Such evidence shall be provided by the Manufacturer/supplier.

1.13.9.14 Equipment Fixing

All equipment mounting and fixing points to be verified as adequate to withstand seismic events nominated in the project documentation, utilising seismic fixings/restraints where required to provide a complete system.

Anti-vibration and acoustic isolations systems shall be fixed with seismically stable isolator mounts or restraints incorporated.

All bracing shall be independent of the main item support (gravity/vertical support system) unless designed by a Seismic Design Specialist. All post-installed anchors for bracing shall meet the requirements of AS5216.

All fixing of equipment to concrete plinths and piers shall be in accordance with seismic requirements from the contractor's Seismic Design Specialist. Plinths shall be designed to withstand seismic loads being imposed by the supported equipment, with adequate depth and edge distances for anchor capabilities and suitably connected to the structure to transfer the required loads.

IL4 structures fix only to building structural elements or to steel framing fixed to structural elements. Do not fix to masonry infill panels unless specifically designed and certified by a Seismic Design Specialist.

1.13.9.15 Bracing Location

The Seismic Design Specialist shall provide bracing locations, restraint capacities, suggested brace types and transparency of calculations.

General rules of bracing

Unless exempted, all building services shall be braced:

- when penetrating walls/soffits/floors, unless directed by Seismic Design Specialist.
- both sides of piping, conduit or ductwork at flexible connections
- to avoid collisions between piping, conduit or ductwork and adjacent other non-structural components
- within 600mm of changes in direction, whether it be horizontal or vertical changes (note that offsets of less than 600mm along a run are not considered a change of direction)
- in both directions at the top of all risers where risers exceed 900mm.

1.13.9.16 Restraint exemption clarification

The exemptions outlined in AS1170.4 Section 8.1.4(b)(x) require specific engineering design knowledge, although the following is noteworthy:

- The exemptions apply to IL2 & IL3 structures only.
- *IL4 structures require a Special Study (Specific Engineering Design) before any exemptions apply.*
- The exceptions only apply to 'individually supported services'.
- If a straight run of service is exempt at one end and ends non-exempt at the other end, then the whole run should be braced, not just the non-exempt section. The same applies where the hanging distance varies from less than 300mm to more than 300mm in a straight run.
- Where below threshold items are supported on a trapeze or multi service hanger exemption is no longer valid.
- Where a mix of exempt and non-exempt items are within the same support exemption does not apply.
- Exemptions do not apply to the following services:
    - Smoke control systems.
    - Emergency electrical systems (including battery racks).
    - Fire and smoke detection systems.
    - Fire suppression systems (including sprinklers).
    - Life safety system components.

- Boilers, furnaces, incinerators, water heaters, and other equipment using combustible energy sources or high energy sources, chimneys, flues, smokestacks, vents and pressure vessels.
- Communication systems (such as cable systems, motor control devices, switchgear, transformers and unit substations).
- Reciprocating or rotating equipment.
- Utility and services interfaces.
- Anchorage of lift machinery and controllers.
- Lift and hoist components including structural frames providing support for guide rail brackets, guide rails and brackets, car and counterweight members
- Escalators
- Machinery (manufacturing and process)
- Lighting fixtures
- Electrical panel boards and dimmers
- Conveyor systems (non-personal)

1.13.10 FINISHES TO BUILDING SERVICES

1.13.10.1 General

If exposed to view (including in plant rooms) paint new building services and equipment.

Do not paint chromium or nickel plating, anodised aluminium, GRP, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces. Surfaces with finishes applied off-site need not be re-painted on-site provided the corrosion resistance of the finish is not less than that of the respective finish in this clause.

1.13.10.2 Standard

Conform to the recommendations of AS/NZS 2311 Sections 3, 6 and 7 or AS/NZS 2312 Sections 5, 8 and 10, as applicable.

1.13.10.3 Powder coating

Powder coating shall be to AS 4506.

Application: Thermoset powder coatings applied to metal substrates including extruded, sheet and sheet cast aluminium, with the exception of aluminium for architectural applications.

Atmospheric classification to AS/NZS 2312:

1. Interior locations: B – low.

2. Exterior locations:

   a. Moderate: C2 – medium.

   b. Marine industrial: D – high.

   c. Tropical: F.

1.13.10.4 Painting systems

New unpainted interior surfaces shall be to AS/NZS 2311 Table 5.1.

New unpainted exterior surfaces shall be to AAS/NZS 2311 Table 5.2.

1.13.10.5 Paint application

Apply the first coat immediately after substrate preparation and before contamination of the substrate can occur. Ensure each coat of paint or clear finish is uniform in colour, gloss, thickness and texture and free of runs, sags, blisters or other discontinuities.

Do not combine paints from different manufacturers in a paint system.

Remove fixtures before starting to paint and refix in position undamaged when painting is complete.

1.13.10.6 Low VOC emitting paints

Provide the following low odour/low environmental impact paint types with the following VOC limits:

1. Primers and undercoats: < 65 g/litre.
2. Low gloss white or light coloured latex paints for broadwall areas: < 16 g/litre.
3. Coloured low gloss latex paints: < 16 g/litre.
4. Gloss latex paints: < 75 g/litre.

1.13.10.7 Underground metal piping

Corrosion protection: Provide corrosion protection for the following:

1. Underground ferrous piping.
2. Underground non-ferrous metal piping in corrosive environments.

1.13.11 MARKING AND LABELLING

1.13.11.1 General

Mark services and equipment to provide a ready means of identification.

Locations exposed to weather: Provide durable materials for locations exposed to weather.

For pipes, conduits and ducts, identify and label to AS 1345.

Label cables to indicate the origin and destination of the cable.

Label and mark equipment using a consistent scheme across all services elements of the project.

Provide marking and labelling text identical to the text and terminology used in operating and maintenance manuals.

1.13.11.2 Labels and notices

Select from the following materials:

1. Cast metal.
2. For indoor applications only, engraved two-colour laminated plastic.
3. Proprietary pre-printed self-adhesive flexible plastic labels with machine printed black lettering.
4. Stainless steel or brass ≥ 1 mm thick with black filled engraved lettering.

Emergency functions shall be to AS 1319.

Colours: Generally to AS 1345 as appropriate, otherwise black lettering on white background except as follows:

1. Danger, warning labels: White lettering on red background.
2. Main switch and caution labels: Red lettering on white background.
3. Edges: If labels exceed 1.5 mm thickness, radius or bevel the edges.
4. Fixing: Fix labels securely using screws, rivets, proprietary self-adhesive labels or double-sided adhesive tape.
5. If labels are mounted in extruded aluminium sections, use rivets or countersunk screws to fix the extrusions.
6. Use aluminium or monel rivets for aluminium labels.
7. Label locations: Locate labels so that they are easily seen and are either attached to, below or next to the item being marked.
8. Label text: To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents.

Lettering heights:

1. Danger, warning and caution notices: ≥ 10 mm for main heading, ≥ 5 mm for remainder.
2. Equipment labels within cabinets: ≥ 3.5 mm.
3. Equipment nameplates: ≥ 40 mm.
4. Identifying labels on outside of cabinets: ≥ 5 mm.
5. Isolating switches: ≥ 5 mm.
6. Switchboards, main assembly designation: ≥ 25 mm.
7. Switchboards, outgoing functional units: ≥ 8 mm.
8. Switchboards, sub assembly designations: ≥ 15 mm.
9. Valves: ≥ 20 mm.
10. Self-adhesive flexible plastic labels :
    a. Labels < 2000 mm above floor: 3 mm on 6 mm wide tape.
    b. Labels ≥ 2000 mm above floor: 8 mm on 12 mm wide tape.
11. Other locations: ≥ 3 mm.

Operable devices: Mark to provide a ready means of identification. Include the following:

1. Controls.
2. Indicators, gauges, meters.

3. Isolating switches.

4. Vapour barriers: Do not penetrate vapour barriers.

1.13.11.3 Piping

Identify piping to AS 1345 throughout its length, including in concealed spaces.

1.13.11.4 Points lists

Automatic control points: Provide plasticised, fade-free points lists for each automatic control panel. Store in a pocket on the door of the panel. Lists to include terminal numbers, point addresses, short and long descriptors.

1.13.11.5 Accessories

Label isolating switches and outlets to identify circuit origin.

1.13.11.6 Equipment concealed in ceilings

Provide a label on the ceiling indicating the location of each concealed item requiring access for routine inspection, maintenance and/or operation. In tiled ceilings locate the label on the ceiling grid closest to the item access point. In flush ceilings locate adjacent to closest access panel. Items to be labelled include but are not limited to:

1. Fan coil units and terminal equipment (e.g. VAV boxes).

2. Fire and smoke dampers.

3. Isolating valves not directly connected to items otherwise labelled.

4. Motorised dampers.

5. Wall mounted equipment in occupied areas: Provide labels on wall mounted items in occupied areas including the services control switches and temperature/humidity sensors.

1.13.12 WARRANTIES

If a warranty is documented or if a manufacturer's standard warranty extends beyond the end of the defects liability period, name the principal as warrantee. Register with manufacturers as necessary. Retain copies delivered with components and equipment.

Commence warranty periods at practical completion or at acceptance of installation, if acceptance is not concurrent with practical completion.

If installation is not by manufacturer, and product warranty is conditional on the manufacturer's approval of the installer, submit the manufacturer's written approval of the installing firm.

1.13.13 RECORD DRAWINGS

1.13.13.1 General

Submit record drawings. Show the 'as installed' locations of building elements, plant and equipment. Include 'as installed' amendments to shop drawings. Show off-the-grid dimensions where applicable.

Date for submission shall not be later than 2 weeks after the date of practical completion.

Show dimensions, types and location of the services in relation to permanent site features and other underground services. Show the spatial relationship to building structure and other services. Include all changes made during commissioning and the maintenance period.

If services and fittings are below ground, show the depth and dimensioned references that will allow the future location of the service for maintenance or expansion.

Include all documented shop drawings.

If a drawing shows extensions and/or alterations to existing installations, include sufficient of the existing installation to make the drawing comprehensible without reference to drawings of the original installation.

Provide diagrammatic drawings of each system including the following:

1. Controls.
2. Piping including all valves and valve identification tags.
3. Dimensioned location, depth and other details of buried or otherwise concealed services.
4. Principal items of equipment.
5. Wiring.
6. Acoustic and thermal insulation.
7. All access provisions.
8. Controls.
9. Fixings.
10. Fixtures.
11. Piping including all valves and valve identification tags.
12. Principal items of equipment.
13. Wiring.

1.13.13.2 Accuracy

Incorporate all modifications made during the progress of the work and testing period. Show any provisions for the future.

Sign and date all record drawings. Keep one set of shop drawings on site at all times expressly for the purpose of marking changes made during the progress of the works.

1.13.13.3 Drawing layout

Use the same borders and title block as the contract drawings.

1.13.13.4 Quantity and format

General: Conform to Submissions.

1.13.14 OPERATION AND MAINTENANCE MANUALS

1.13.14.1 General

Submit operation and maintenance manuals for the whole of the work.

The authors and compilers of the operation and maintenance manuals (O&M manuals) shall be a personnel experienced in the maintenance and operation of equipment and systems installed, and with editorial ability.

If referenced documents or technical worksections require that manuals be submitted, include corresponding material in the operation and maintenance manuals.

Subdivide the O&M manuals by installation or system, depending on project size.

Date for draft submission: 2 weeks prior to commencement of training.

Date for final submission: Within 2 weeks after practical completion.

1.13.14.2 Contents

Include the following:

1. Table of contents: For each volume. Title to match cover.

2. Directory: Names, addresses, and telephone and facsimile numbers of principal consultant, subconsultants, contractor, subcontractors and names of responsible parties.

3. Drawings: Complete set of record drawings, full size.

4. Drawings and technical data: As necessary for the efficient operation and maintenance of the installation including the following:

    a. Instructions and schedules: To AS 1851, AS/NZS 3666.2 and AS/NZS 3666.3 prepared to included project specific details.

    b. Instructions on the use of special pipe jointing methods including the use of special tools.

    c. Single line electrical diagrams.

    d. Electrical service route layouts.

5. Switchgear and controlgear assembly circuit schedules including electrical service characteristics, controls and communications.

6. Installation description: General description of the installation.

7. Systems descriptions: Technical description of the systems installed, written to make sure the principal's staff fully understand the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions.

8. Systems performance: Technical description of the mode of operation of the system installed.

9. Equipment descriptions:

    a. Name, address and telephone and facsimile numbers of the manufacturer and supplier of items of equipment installed, together with catalogue list numbers.

    b. Schedules (system by system) of equipment, stating locations, duties, performance figures and dates of manufacture. Provide a unique code number cross-referenced to the record and diagrammatic drawings and schedules, including spare parts schedule, for each item of equipment installed.

c. Manufacturers' technical literature for equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.

d. Supplements to product data to illustrate relations of component parts. Include typed text as necessary.

e. Certificates:

f. Certificates from authorities.

g. Copies of manufacturers' warranties.

h. Product certification.

i. Copies of test certificates for the mechanical installation and equipment used in the installation.

j. Test and balancing reports.

k. All control system testing and commissioning results.

10. 7 day record of all trends at commissioning.

11. Operation procedures:

a. Safe starting up, running-in, operating and shutting down procedures for systems installed. Include logical step-by-step sequence of instructions for each procedure.

b. Control sequences and flow diagrams for systems installed.

c. Legend for colour-codes services.

d. Schedules of fixed and variable equipment settings established during commissioning and maintenance.

e. Procedures for seasonal changeovers.

12. Maintenance procedures:

a. Detailed recommendations for preventative maintenance frequency and procedures.

b. Manufacturer's technical literature as appropriate. Register with manufacturer as necessary. Retain copies delivered with equipment.

c. Safe trouble-shooting, disassembly, repair and reassembly, cleaning, alignment and adjustment, balancing and checking procedures. Provide logical step-by-step sequence of instructions for each procedure.

d. Schedule of spares recommended to be held on site, being those items subject to wear or deterioration and which may involve the principal in extended deliveries when replacements are required. Include complete nomenclature and model numbers, and local sources of supply.

e. Schedule of normal consumable items, local sources of supply ,and expected replacement intervals up to a running time of 40 000 hours. Include lubrication schedules for equipment.

f. Schedule of maintenance work including frequency and manufacturers' recommended tests.

g. Instructions for use of tools and testing equipment.

h. Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding.

i. Material safety data sheets (MSDS).

13. Electrical equipment certificates:

    a. Copies of test certificates for the installation and equipment used in the installation.

    b. Test reports.

14. Electrical drawings:

    a. Single line diagrams for all systems included and/or affected by the works.

    b. Service route layouts.

    c. Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.

15. Maintenance records:

    a. Documentation shall be to AS 1851 clause 18.2.5.

    b. Submit, in binders which match the manuals, loose leaf log book pages designed for recording completion activities including operational and maintenance procedures, materials used, test results, comments for future maintenance actions and notes covering the condition of the installation. Include completed log book pages recording the operational and maintenance activities performed up to the time of practical completion.

    c. Number of pages: The greater of 100 pages or enough pages for the maintenance period and a further 12 months.

16. Operation procedures including, but not limited to, the manufacturers' technical literature as appropriate.

17. Mechanical drawings:

    a. Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.

    b. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

18. Recommissioning instructions.

19. Prototype periodic maintenance and performance report.

20. Documentation to AS 1851 clause 18.2.4 including the schedule of essential functionality and performance requirements.

21. Prototype periodic maintenance records for compliance with AS 1851 prepared to include project specific details.

22. See AS 1851 Figures 18.2.7(A) to (D) for samples of these.

23. Schedules to be used for recording recommissioning data so that changes in the system over time can be identified.

24. Instructions and schedules for conforming to AS 1851, AS/NZS 3666.2 and AS/NZS 3666.3.

1.13.14.3 Format – electronic copies

Except for drawings required in the Record drawings clause provide material that can be legibly printed on A4 size paper.

Provide the same material as documented for hardcopy in electronic format.

Number of copies: 3.

1.13.14.4 Format – hard copy

General: A4 size loose leaf, in commercial quality, 4 ring binders with hard covers, each indexed, divided and titled. Include the following features:

1. Cover: Identify each binder with typed or printed title 'OPERATION AND MAINTENANCE MANUAL', to spine. Identify title of project, volume number, volume subject matter, and date of issue.

2. Dividers: Durable divider for each separate element, with typed description of system and major equipment components. Clearly print short titles under laminated plastic tabs.

3. Drawings: Fold drawings to A4 size and accommodate them in the binders so that they may be unfolded without being detached from the rings. Provide with reinforced punched binder tabs.

4. Pagination: Number pages.

5. Ring size: 50 mm maximum, with compressor bars.

6. Text: Manufacturers' printed data, including associated diagrams, or typewritten, single-sided on bond paper, in clear concise English.

Number of copies: 3.

1.13.15 MAINTENANCE

1.13.15.1 General

During the maintenance period, carry out periodic inspections and maintenance work as recommended by manufacturers of supplied equipment, and promptly rectify faults.

Attend emergency calls promptly.

Carry out recommended annual maintenance procedures before the end of the maintenance period.

Maintenance period shall be the greater of the defects liability period and the period nominated herein.

1.13.15.2 Maintenance program

Submit details of maintenance procedures and program, relating to installed plant and equipment, 6 weeks before the date for practical completion. Indicate dates of service visits. State contact telephone numbers of service operators and describe arrangements for emergency calls.

1.13.15.3 Maintenance records

Submit, in binders which match the manuals, loose leaf log book pages designed for recording completion activities including operational and maintenance procedures, materials used, test results, comments for future maintenance actions and notes covering the condition of the installation. Include completed log book pages recording the operational and maintenance activities performed up to the time of practical completion.

Include test and approval certificates.

On satisfactory completion of the installation and before the date of practical completion, submit certificates stating that each installation is operating correctly.

Number of pages: The greater of 100 pages or enough pages for the maintenance period and a further 12 months.

Referenced documents: If referenced documents or technical worksections require that log books or records be submitted, include this material in the maintenance records.

Service visits: Record comments on the functioning of the systems, work carried out, items requiring corrective action, adjustments made and name of service operator. Obtain the signature of the principal's designated representative.

1.13.15.4 Site control

Report to the principal's designated representative on arriving at and before leaving the site.

1.13.16 TOOLS AND SPARE PARTS

Provide spare parts listed in the appropriate worksections.

1.13.16.1 Tools and spare parts schedule

At least 8 weeks before the date for practical completion, submit a schedule of tools, portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer's current price. Include the following in the prices:

1. Checking receipt, marking and numbering in accordance with the spare parts schedule.
2. Packaging and delivery to site.
3. Painting, greasing and packing to prevent deterioration during storage.
4. Referencing equipment schedules in the operation and maintenance manuals.
5. Suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.

Replace spare parts consumed during the maintenance period.

1.13.17 COMMISSIONING AND COMPLETION TESTS

1.13.17.1 Reports

Submit reports indicating observations and results of tests and compliance or non-compliance with requirements.

1.13.17.2 Notice

Give sufficient notice for inspection to be made of the commissioning and completion testing of the installation.

1.13.17.3 Controls

Calibrate, set and adjust control instruments, control systems and safety controls.

1.13.17.4 Samples

Remove unincorporated samples on completion.

1.13.17.5 Circuit protection

Confirm that circuit protective devices are sized and adjusted to protect installed circuits.

1.13.17.6 Completion tests

Test the works under the contract to demonstrate compliance with the documented performance requirements of the installation.

Carry out functional and operational checks on energised equipment and circuits and make final adjustments for the correct operation of safety devices and control functions.

Submit type test reports confirming compliance of proprietary equipment.

Sound pressure level measurements: Conform to the following:

1. Correction for background noise: To AS/NZS 2107 Table B1.

2. External: To AS 1055.1.

3. Internal: To AS/NZS 2107.

4. Measurement positions: If a test position is designated only by reference to a room or space, do not take measurements less than 1 m from the floor, ground or walls.

5. Sound pressure level analysis: Measure the sound pressure level and the background sound pressure level over the full range of octave band centre frequencies from 31.5 Hz to 8 kHz at the designated positions.

6. Sound pressure levels: Measure the A-weighted sound pressure levels and the A-weighted background sound pressure levels at the designated positions.

Use instruments calibrated by a registered testing authority.

1.13.18 TRAINING

1.13.18.1 General

Instruction to be available for the whole of the commissioning and running-in periods.

Conduct training at agreed times, at system or equipment location. Also provide seminar instruction to cover all major components.

Use items and procedures listed in the final draft operation and maintenance manuals as the basis for instruction. Review contents in detail with the principal's staff.

Provide written certification of attendance and participation in training for each attendee. Provide register of certificates issued.

1.13.18.2 Demonstrators

Use only qualified manufacturer's representatives who are knowledgeable about the installations.

1.13.18.3 Maintenance

Explain and demonstrate to the principal's staff the purpose, function and maintenance of the installations.

1.13.18.4 Operation

Explain and demonstrate to the principal's staff the purpose, function and operation of the installations.

1.13.18.5 Seasonal operation

For equipment requiring seasonal operation, demonstrate during the appropriate season and within 6 months.

1.13.19 CLEANING

Final cleaning: Before practical completion, clean throughout, including all exterior and interior surfaces except those totally and permanently concealed from view.

Remove all labels not required for maintenance.

1.13.20 POST-CONSTRUCTION MANDATORY INSPECTIONS AND MAINTENANCE

For the duration of the defects liability period, provide inspections and maintenance of safety measures required by the following:

1. The Building Code of Australia.
2. AS 1851.
3. Other statutory requirements applicable to the work.

Records: Provide mandatory records.

Certification: Certify that mandatory inspections and maintenance have been carried out and that the respective items conform to statutory requirements. Submit certification.

Annual inspection: Provide an annual inspection and maintenance immediately prior to the end of the defects liability period.

SECTION 2 - EQUIPMENT

2.1 AIR COOLED PACKAGED AND OR SPLIT AIR CONDITIONING UNITS

2.1.1 GENERAL

Provide packaged or split air conditioning units consisting of fan-coil section and compressor-condenser section together with all refrigerant condensers, compressors, supply air fan, cooling coil and associated piping, insulation, air filters, electrical connections and operating and safety controls which are essential for the satisfactory operation of the unit

All units shall be compliant with the latest MEPS requirements, or the EER requirements as noted in the latest version of the BCA, Section J5. Units shall be suitable for providing continuous operation in ambient conditions between -5˚C and 46˚C without excessive head pressure and unstable operation or icing.

The unit components shall be of approved proprietary manufacture, factory assembled and tested to AS/NZ 3823.

The units shall be capable to provide the performance requirements as documented in the *Schedule of Equipment*. The units shall be reverse cycle or cooling only as documented in the *Schedule of Equipment*.

2.1.2 CABINETS

Provide enclosures, materials and finishes that are weatherproof and corrosion-resistant, assembled and reinforced to prevent flexing and drumming.

The enclosure shall be fabricated using galvanized steel with a minimum thickness of 1.0 mm for the panels and a minimum thickness of 1.6 mm for the base and legs. The enclosure shall be powder coat all metallic-coated steel interior and exterior surfaces to AS 3715 or AS 4506 as appropriate.

All parts shall have free draining with no pockets in which condensation and/or rainwater may be retained.

All fasteners exposed to weather shall be stainless steel.

The cabinet shall be sealed to prevent air loss. Access panels shall be sized to provide adequate access for maintenance and for removal of major components. Access panels shall be air tight. As a minimum, provide access to the condensate tray, supply fan motor and drive, compressor section, condenser section and filter section.

Insulate enclosures to prevent external surface condensation under all operating conditions. Fix insulation to panels with waterproof adhesive. The insulation shall be non-hygroscopic and shall have a thermal conductivity ≤ 0.035 W/m.K with a minimum thickness of 25 mm. Insulation shall be faced with a reinforced aluminium foil. The insulation fire hazard properties shall be in accordance with AS 4254.

Provide a tray under each cooling coil extending downstream to collect water carry over and under any other components on which condensation may occur. Grade trays and sumps to the outlet to prevent water retention. Provide radiused corners and arrange to facilitate cleaning. Fabricate the trays from aluminium to AS/NZS 1734 or stainless steel sheet grade 304L.

Provide metallic-coated steel mesh protection to outdoor fans and exposed faces of outdoor coils.

2.1.3 SUPPLY FAN

Select fans and fan motors so the air flow can be increased ≥ 5% above the documented design air flow rate, against the corresponding increased system resistance by fan speed change alone and without unstable operation.

For multi-speed motors, select for the required duty as documented in the Schedule of Equipment at the second highest speed.

Supply fans shall be forward curved centrifugal fans with correctly designed, statically and dynamically balanced impellers. Fan bearings shall be of the self-aligning "sealed for life" ball or roller type.

Fans shall be belt driven with adjustable drive pulleys. Completely isolate fan and motor assembly from the unit frame with rubber mounts. Fan and motor shall be capable of the maximum air flow capacity of the unit at the systems resistance as installed.

2.1.4 CONDENSER FAN

Condenser fans shall be propeller type fans, direct driven with single thickness fixed pitch aluminium or UV protected polypropylene blades. Fans shall be statically and dynamically balanced for quiet operation.

Provide easily removable powder coat finished metallic-coated steel guards over condenser fans.

If multiple fans operate in sequence for capacity control, provide baffles in the condenser to prevent air short circuiting through idle fans.

2.1.5 FAN MOTORS

Power rating of supply fans shall be at least the power required by the fan when the air flow is increased by 10% above the design air flow rate stated in the schedules, against the corresponding increased system resistance as installed.

Single phase motors: ≤ 0.37 kW only.

Fan motor speed shall be less than 25 rev/s.

Bearings shall be sealed for life type ball bearings.

Minimum degree of protection:

1. Supply fans: IP54.
2. Condenser fans: IP55.

Insulation to AS 60034.1:

1. Single phase motors: Minimum Class B.
2. Three phase motors: Minimum Class F.

2.1.6 COMPRESSORS

The compressors shall be scroll or reciprocating type with the enclosure welded or accessible hermetic steel with at least three mounting feet.

Also provide the following:

1. Mounting: Vibration isolating mountings.

2. Service valves: Packed and capped, backseating refrigerant suction valve.

3. Charging connections: Schreader type connections for evacuation and refrigerant charging.

4. Crankcase heaters: Provide integral positive temperature coefficient type crankcase heaters if required for safe compressor operation.

5. Scroll compressors: Provide reverse rotation protection.

2.1.7 COILS

Arrange coils and casing so that both sides of coils are easily accessible for inspection and cleaning

Coil face velocity shall be less than 2.5 m/s and coils shall be minimum 3 rows deep.

Coils shall be fabricated from copper tubes and aluminium alloy plate fins with minimum fins thickness of 0.12 mm. Tubes and fins shall be firmly bonded together.

2.1.8 REFRIGERATION SYSTEM

Refrigerant shall be R32, R407C or R410A.

Multiple compressor units shall be provided with separate refrigeration circuit for each compressor.

Refrigerant expansion devices shall be as follows:

1. < 20 kW total capacity: Eliminator or similar, non-capillary expansion device, thermostatic expansion valve or electronic expansion valve.

2. ≥ 20 kW total capacity: Thermostatic expansion valve or electronic expansion valve.

Each refrigeration circuit shall be provided with a sight glass-moisture indicator, filter dryer and manual reset high pressure and auto reset low pressure cutouts. Provide a suction accumulator if compressor is liable to damage by liquid slugs.

For reverse cycle units, provide refrigerant reversing valve and an effective outdoor coil defrost facility that prevents room temperature dropping more than 2 K during defrost.

2.1.9 DRIP TRAYS

Provide suitably sized drip trays to collect all condensation from the FCU and associated valves.

Drip trays shall be stainless steel or heavy galvanised mild steel and shall be externally insulated.

2.1.10 CONDENSATE DRAINS

Provide trapped drain lines to connect condensate trays to the nearest building drain point. Discharge outside the air handling unit, to allow visual inspection of condensate flow.

Provide transparent, kink resistant hose or another clear, removable joint at the unit. Provide means to clean and remove the trap.

Trap depth to withstand > 2 times the fan static pressure.

Provide drains with uniform and continuous fall ≥ 10 mm/m. Provide condensate drain pumps as necessary.

Seal drain pipes to casing with rubber grommets.

Test drains by pouring a measured quantity of water in upstream end.

Minimum condensate drain pipe to be 32 mm diameter copper pipe.

2.1.11 CONTROLS AND ELECTRICAL

Provide factory wired control panel for each unit containing the following:

- Plug-in relays.
- Terminal strips numbered to correspond to wiring diagram.
- Starter and overload protection for each motor.
- Short circuit protection: Provide each compressor and each 3-phase motor with short circuit protection
- Provide automatic lead/lag changeover for units with multiple compressors.
- Short cycle timer function: To limit compressor starts.
- Separate control and electrical circuit for each compressor.
- HRC fuse or circuit breaker short circuit protection for each crankcase heater (if fitted) and control circuit.
- Phase failure protection on motors ≥ 5.5 kW.
- Terminals for remote indication of run and fault conditions.
- Permanent, weatherproof, wiring diagram fixed on or next to the control panel.

Safety controls shall be arranged so that operation of one item does not shut down other items that are not directly dependent on its operation. Include as a minimum the following safety and operating controls:

1. High discharge pressure cut out.
2. Low suction pressure cut out.
3. Low oil pressure cut out.
4. Automatic de-icing controls.
5. All protective devices to be manual reset.

Provide an isolating switch for each system.

2.1.12 INSTALLATION

Support unit on anti-vibration mountings and bolt unit in place with minimum 4 anchors or suspension rods.

Provide a flexible connection between unit and ductwork maintaining a minimum of 75mm clearance between metal edges. Ductwork shall be accurately aligned with equipment spigot, and not rely on flexible section to achieve connection.

Maintain manufacturer's recommended clearances for access to the unit's internal components. Make sure discharge air does not short-circuit to condenser intake.

If unit is located on grassed or similar permeable surfaces provide concrete plinths under the packaged air conditioning unit and under the outdoor unit for the split systems.

2.2 PACKAGED AIR CONDITIONING UNITS AIR COOLED VRV/VRF TYPE

2.2.1 GENERAL

The variable refrigerant volume (VRV) system also known as variable refrigerant flow (VRF) system shall be air cooled, split type multi-system air conditioner consisting of one outdoor unit and plural indoor units, each having capability to cool or heat independently for the requirements of the rooms.

Different type and capacity indoor units can be connected to one refrigerant circuit and controlled individually. The single VRV system shall be capable of handling a range from 50%-130% connected indoor capacity without unstable operation.

Compressor shall be equipped with inverter controller, and capable of changing the rotating speed to follow variations in cooling and heating load.

The two pipe system shall be utilised such that all fan coil units shall cool or heat at the same instance. The three pipe system shall be utilised such that individual groups of fan coil units may cool or heat independently in the same system.

All units shall be compliant with the latest MEPS requirements, or the EER requirements as noted in the latest version of the BCA, Section J5. Units shall be suitable for providing continuous operation in ambient conditions between -5˚C and 46˚C without excessive head pressure and unstable operation or icing.

2.2.2 CONDENSING UNIT

The outdoor unit shall be factory assembled unit housed in a sturdy weatherproof casing constructed form rust-proofed mild steel panels coated with a baked enamel finish. The condensing shall be factory pre-charged with refrigerant and pre-wired with all necessary electronic and refrigeration controls.

The outdoor unit is able to operate by other outdoor unit even in case that one of the compressors in the unit is out of order (Multi-unit).

The outdoor unit has two compressors and is able to operate even in case that one of the compressors is out of order (Single unit).

The noise level shall not be more than 58 dB (A) at normal operation measured horizontally 1 m away and 1.5 m above ground.

The condenser shall be modular in design and shall allow for side by side installation.

The condenser unit fan motors shall have multiple speed operation and shall be of high static resistance type of 50Pa.

Each outdoor unit shall have installed a field supplied condensate drain tray of galvanised sheet steel construction. A 25mm drain pipe shall connect the condensate drain tray with the nearest floor waste.

2.2.2.1 Compressors

The compressors shall be highly efficient hermetic scroll type and equipped with inverter control capable of changing the speed in accordance to the cooling and heating load requirements.

The outdoor unit shall have the multi-step of capacity control to meet load fluctuation and indoor unit individual control.

2.2.2.2 Heat Exchanger

The heat exchanger shall be constructed with seamless copper tubes mechanically bonded to aluminium fins to form a cross fin coil. The aluminium fins shall be covered by an anti-corrosion resin film.

2.2.2.3 Refrigerant Circuit

The refrigerant circuit shall include liquid and gas shut off valves and solenoid valves.

All necessary safety devices shall be provided to ensure the safety operation of the system.

2.2.2.4 Safety Devices

The following safety devices shall be part of the outdoor unit:

High pressure switch, fuses, crankcase heater, fusible plug, over current protector for inverter and short re-cycling guard timer.

2.2.2.5 Oil Recovery

Units shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping.

2.2.2.6 Selection Switches

The condensing unit PCB shall have selection switches for the length of pipe work, ambient range selection, emergency operation switches and service mode switches, together with LED indications for the number of fan coil units connected, frequency status and operation/fault indication.

2.2.3 INDOOR UNITS

The indoor units shall be capable to provide the performance requirements as documented in the *Schedule of Equipment*. The indoor units' type shall be as documented in the *Schedule of Equipment*.

The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation.

Coils shall be constructed from copper tubes expanded into aluminium fins to form a mechanical bond.

The indoor units shall have electronic control valve which control refrigerant flow rate in respond to load variations of the room.

The address of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, it shall be set by liquid crystal remote controller.

The fan coil unit casing shall be fully insulated and sealed to prevent condensation.

Provide condensate pumps when necessary and 32mm condensate drain pipes from each fan coil unit to the nearest waste. These condensate pipes shall be insulated.

Control

Computerized PID control shall be used to maintain a correct room temperature.

Unit shall be equipped with a self-diagnosis for easy and quick maintenance and service.

The LCD (Liquid Crystal Display) remote controller shall memorize the latest malfunction code for easy maintenance. It shall be able to control up to 16 indoor units and change fan speed and angle of swing flap individually in the group.

Refer to worksection “AUTOMATIC CONTROLS AND BUILDING MANAGEMENT SYSTEMS” elsewhere in this specification for the control strategy of each unit.

2.2.4 REFRIGERANT PIPEWORK

The complete refrigerant pipework installation shall be in complete compliance with the manufacturer recommendations and literatures which take precedence to any clause in this specification.

Supply, install, test and commission all interconnecting pipework between the condensing unit and the fan coil units as specified in the Clause Refrigerant Piping elsewhere in this specification together with all refrigerant pipes insulation as necessary.

Pipework shall be refrigerant quality deoxidised phosphorus seamless copper tube with brazed connections and shall be branched with the appropriate REFNET headers and joints.

Longest possible lengths of copper pipe should be utilised to minimise joints on site and appropriate refrigeration tools must be utilised to avoid the use of elbows. The REFNET refrigeration pipe joints and headers shall be installed in and appropriate orientation to enable correct distribution of refrigerant.

Additional refrigerant charge weight must be calculated to the actual length of the refrigerant pipework. The refrigerant charging process must be carried out with an appropriate charging station and under supervision.

Pipework shall be properly and tidily fixed and supported at a minimum of 2 metre centres by galvanised mild steel brackets and where required shall be run on galvanised trays.

2.2.5 BRANCH SELECTOR UNIT (FOR HEAT RECOVERY SYSTEMS)

Supply and install branch selector (BS) unit boxes where indicated in the *Schedule of Equipment* that the system is a three pipe (heat recovery system) and to the manufacturer’s specifications.

The BS units shall have two solenoid valves which are opened by a signal to cool or heat from the remote controller.

The branch sector unit shall be factory pre-wired and pre-piped and internally insulated.

2.3 FAN COIL UNITS

The units shall be capable to provide the performance requirements as documented in the *Schedule of Equipment*. The units shall be floor or ceiling mounted and shall be provided with hot water heating coils or electric heaters as documented in the *Schedule of Equipment*.

Provide units complete with coils, filters, insulated drain pan, access panels, control valves, three speeds or variable speed fan control and all associated components.

Fan coil units supply and installation shall be in compliance with AS4254, AS 1668.1, AS/NZS 3666.1, AS/NZS 3666.2 and the recommendations of SAA/SNZ HB 32.

Submit certified reports, calculations and other details to demonstrate that the documented performance will be achieved with the equipment offered.

2.3.1 COILS

Comply with clause “AIR COILS” elsewhere in this worksection.

In general, coils shall be in accordance with AHRI 410 requirements and shall be solid drawn copper tubes with aluminium plate fins. The headers shall be copper or steel and shall be provided complete with vents and drains.

Leak test coils to the greater of 2 MPa or 2 times the working pressure for at least 1 hour by either submerging in warm water and applying air or other gas under pressure or by hydrostatic test.

Electric heating coils shall be constructed and provided with all safety features in accordance with AS1668.1.

2.3.2 CASINGS

Provide the unit with an enclosure consisting of panels, grilles and louvres, fabricated from machine-folded sheet metal, reinforced where necessary with stiffening channels or angles, capable of supporting and retaining the components of the assembly without excessive noise and vibration. Provide adequate drainage.

For exposed units, provide removable prefinished 1.2 mm metallic-coated steel cabinet with extruded aluminium supply grille for units exposed to view.

For concealed units, provide 1.2 mm galvanized steel casing for units located above ceilings or otherwise concealed.

Provide access panels with quick release, captive fasteners. Do not use self-tapping screws.

Baffle plates: Close the space between the coil frames, fans and filters and the surrounding structure or equipment, with baffle plates. Seal gaps between coils and surrounding structure or equipment.

Coil supports: Support coils using the internal support frame of the unit.

Dissimilar metals: Provide neoprene gaskets to separate the mating surfaces of dissimilar metals. Provide non-metallic top hat washers in enlarged holes under nuts and bolts connecting dissimilar metals.

Insulation: Insulate and vapour seal to prevent condensation on the outside of unit. Minimum R-value shall be greater or equal to 0.4 m^2.K/W.

Insulation material: Semi-rigid or batt form in conformance with the **Materials** clause in the *Ductwork insulation* worksection.

Insulation Facing: Factory applied perforated aluminium foil laminate.

2.3.3 DRIP TRAYS

Provide suitably sized drip trays to collect all condensation from the FCU and associated valves.

Drip trays shall be stainless steel or heavy galvanised mild steel and shall be externally insulated.

2.3.4 SUPPLY FANS

Provide direct driven forward curved centrifugal selected to ensure that the operation point is within the stable region of the fan's characteristic performance curve. Provide fans selected to deliver the scheduled air flow at ≤ 80% of highest speed.

Fan shall be provided with three speed windings or variable speed control.

Balance and provide self aligning sealed for life ball bearings.

2.3.5 FILTERS

Filters shall be dry media disposable/washable type with 60% efficiency (no.2 dust test) to AS 1324.

Filters shall be installed in frame for the ease of removal.

2.3.6 INSTALLATION

2.3.6.1 Storage

Protect equipment on site from damage and the entry of water or foreign matter.

2.3.6.2 Access and removal

Keep adjacent equipment and ductwork clear of the fan coil units. Provide flanges or spigots for connection to adjacent equipment and ductwork.

Install piping to coils to allow access to equipment, and to minimise disturbance to piping when coils are removed. Arrange piping and isolating valves to minimise drain-down if coil is removed.

Arrange fan coil units and adjacent equipment to permit safe removal of coils, fans and fan shafts without disturbing other adjacent items or building.

2.3.6.3 Vibration

Mount the whole unit on vibration isolating mounts.

2.3.6.4 Supports and fixings

Suspended units: Provide ≥ 4 hangers.

Floor mounted units: Fix in position at ≥ 4 points to prevent horizontal or vertical movement.

Fixings: Do not restrict effectiveness of vibration isolation.

2.3.6.5 Protection

Prevent ingress of foreign matter and moisture during transport and storage. Provide end caps for the pipework

Prevent damage to fins, piping and connections during transport, storage and installation.

Comb damaged fins straight.

2.3.6.6 Connections

Provide piping, isolating valves and unions at each unit so the fan coil assembly can be easily removed and replaced. Conceal piping to units exposed within rooms. Prevent stress on coils by independently supporting piping to coils. Arrange piping and isolating valves to minimise drain-down if coil is removed.

Make all electrical connections to the unit through a terminal strip or multi-pin plug arranged to facilitate easy removal of the fan coil unit.

Provide flexible duct connections at unit.

2.3.6.7 Access panels – concealed fan coil units

Provide access panels for the following:

- Inspection and cleaning upstream and downstream sides of coils.
- Filter removal and replacement.

Access panel's construction shall match the associated unit casing construction and insulation. Provide silicone rubber or soft neoprene gaskets. Provide minimum 2 wedge type sash latches and a handle on each panel.

2.3.6.8 Condensate drains

Provide trapped drain lines to connect condensate trays to the nearest building drain point. Discharge outside the air handling unit, to allow visual inspection of condensate flow.

Provide transparent, kink resistant hose or another clear, removable joint at the unit. Provide means to clean and remove the trap.

Trap depth to withstand > 2 times the fan static pressure.

Provide drains with uniform and continuous fall ≥ 10 mm/m. Provide condensate drain pumps as necessary.

Seal drain pipes to casing with rubber grommets.

Test drains by pouring a measured quantity of water in upstream end.

Minimum condensate drain pipe to be 32 mm diameter copper pipe.

2.4 AIR COILS

2.4.1 GENERAL

Provide air coils rating to meet the performance as specified in the *Schedule of Equipment*. Rating shall be in accordance with AHRI 410

Coils face velocity shall be as follows:

1. Cooling coils: ≤ 2.25 m/s.
2. Heating coils: ≤ 3.5 m/s.
3. Condenser coils: ≤ 3.5 m/s.

Coils fin pitch shall be follows:

1. Cooling coils: ≤ 315 fins/m.
2. Heating coils: ≤ 480 fins/m.

Coils maximum water pressure drop shall be as follows:

1. Cooling coils: ≤ 30 kPa.
2. Heating coils: ≤ 20 kPa.

2.4.2 PRE-COMPLETION TESTS

Pressure test coils for leakage at least for 1 hour by either of the following methods:

1. Submerging in warm water and applying air or other gas under pressure.
2. Hydrostatic test.

Minimum test pressure shall be the greater of 2 MPa or 1.5 times the working pressure.

For refrigerant coils, and after testing, dehydrate, charge with dry nitrogen to 7 kPa (minimum), and seal.

2.4.3 COILS FABRICATION

2.4.3.1 Arrangement

Arrange tubes with uniform spacing in a staggered pattern.

2.4.3.2 Fins

Provide plate fins to tubes. Space equally, perpendicular to the tubes.

Provide collars to control fin spacing and provide a permanent mechanical bond between the tubes and the plate fins, by expanding tubes into fin collars, so that fin collars completely cover the tubes.

Fins material shall be as follows:

1. Heating coils, condenser coils and non-sprayed cooling coils: Aluminium alloy to AS 2848.1, designation 3003 or 8011.
2. Sprayed cooling coils: Copper.

Fins thickness shall be as follows:

1. Aluminium alloy: ≥ 0.12 mm.
2. Copper: ≥ 0.15 mm.

2.4.3.3 Frames

Form rigid frames, from channel-type tube sheets and top and bottom channels and intermediate tube sheets as necessary.

Minimum flange height (to provide for duct connections): 25 mm.

Provide drain holes in cooling coil frames where water may collect.

Frame material for aluminium finned coils shall be as follows:

1. Cooling coils: Aluminium alloy to AS 2848.1, designation 5005.

2. Heating coils: Aluminium alloy to AS 2848.1, designation 5005, or metallic-coated steel sheet coating class Z275.

Frame material for copper finned coils shall be heavy gauge brass, designation 260.

2.4.3.4 Air leakage

Minimise air leakage through gaps between the fin ends and frames.

Recess fin ends into the top and bottom channels, close gaps with sealing strips, or gaps to a maximum clearance of 1.5 mm.

2.4.3.5 Corrosion protection

Provide a proprietary corrosion protection coating for coils used in a corrosive atmosphere.

For coils with copper fins, electro-tin the coil assemblies after manufacture.

2.4.4 REFRIGERANT COILS

2.4.4.1 Direct expansion coils

Piping connections: Provide pressure type liquid distributors and suction headers, with brazed joints.

Tube arrangement: For multiple circuits, provide interleaving.

Tube material: Copper to AS/NZS 1571 or AS 1572 designation C12200.

Header material: Copper to AS 1432 or AS/NZS 1571.

2.4.4.2 Condensing coils

Piping connections: Factory fit copper pipe connection stubs to refrigerant hot gas inlet and liquid outlet headers using brazing or braze welding. Pressurise with dry nitrogen, then seal.

Tube arrangement: So that liquid refrigerant can gravitate to the outlet header without being trapped in the coil.

Tube material: Copper to AS/NZS 1571 or AS 1572 designation C12200.

Header material: Copper to AS 1432 or AS/NZS 1571.

2.4.5 MARKING

Provide labels showing the following:

1. Manufacturer’s name.

2. Model.

3. Serial number.

2.4.6 INSTALLATION

2.4.6.1 Protection

Prevent ingress of foreign matter and moisture during transport and storage by temporary sealing of end connections as follows:

1. Water coils: Plastic end caps.

2. Refrigerant coils: Seal connections.

Prevent mechanical damage to fins, piping and connections during transport, storage and installation by covering with double corrugated cardboard or hardboard fixed securely.

Protect all coils against damage during and after installation.

2.4.6.2 Coils

Install coils so that fluid and air flow directions are counter flow.

For heating coils in ductwork, Provide coils with flanged frames, for connection to ductwork. Support coils from above on drop rods or from the floor on frames fabricated from hot rolled mild steel angles.

Comb damaged fins straight.

2.4.6.3 Piping

Install piping to coils to allow access to equipment, and to minimise disturbance to piping when coils are removed. Arrange piping and isolating valves to minimise drain-down if coil is removed. Provide unions on connections ≤ DN 50 and flanges on connections > DN 50.

Prevent stress on coils by supporting piping to coils independently.

2.4.6.4 Coil Banks

Provide coil banks as necessary to suit duties specified. Maximum height of coil shall not exceed 1250 mm.

2.4.6.5 Dissimilar Metals

Provide neoprene gaskets to separate the mating surfaces of dissimilar metals.

2.4.6.6 Air Leakage

Close the space between the coil frame and the surrounding structure or equipment, with baffle plates.

Seal gaps between coils and surrounding structure or equipment with non-hardening mastic.

2.4.6.7 Access and Removal

Keep adjacent equipment and ductwork clear of coils and provide flanges to adjacent equipment and ductwork. For duct-mounted coils, provide an access panel in the duct on the air inlet side.

Install piping to coils to allow access to equipment, and to minimize disturbance to piping when coils are removed.

Prevent stress on coils by supporting piping to coils independently.

2.4.6.8 Drain Trays

Provide drain trays which extend under all uninsulated pipe valves and fittings. Extend a DN40 drain pipe from the lowest drip tray or drip pan to a drain point from top of the coil to the outside the conditioner. Incorporate the following:

1. Air break.

2. Sealing of drain pipes to the casing with rubber grommets.

3. Trapped water seal against double the static pressure of the air handling unit.

2.5 AIR FILTERS

2.5.1 GENERAL

Air filters performance, construction and microbial control shall be in accordance with AS 1324.1, AS/NZS 3666.1 and the recommendations of SAA/SNZ HB 32.

For each type of filter, submit evidence of filter type tests conducted by a registered testing authority within the past 5 years and tested to the following Standards:

1. Other particulate filters: To AS 1324.2.

Filter size for test shall be 610 x 610 mm face dimension.

2.5.2 MATERIALS

Sealant shall be resistant to air, entrained water and oil, and microbial growth.

Adhesive performance:

1. Characteristics under environmental conditions: Odourless and non-toxic. Non-migrating, non-evaporating and non-hardening, and resistant to microbial growth.

2. Environmental conditions: Normal temperature, sustained temperatures up to 60°C, and operating air velocities.

2.5.3 COMPONENTS

Component sizes

Standardised throughout the installation as far as practicable.

Filters

For filters of the same type provide filters from only one manufacturer.

Filter performance

Minimum performance shall be in accordance with AS 1668.2.

Metal components

Material: Stainless steel or metallic-coated steel with powder coat finish.

Cell frames

Cell frame shall be capable of withstanding distortion arising from the final pressure drop across the filter.

Frames must stop air by-passing the filter media.

Holding frames

Holding frames shall be true and square. Provide gaskets and clamping systems which maintain an airtight seal between the frame and the filter.

Material: Stainless steel or metallic-coated steel with powder coat finish.

2.5.4 FILTER PERFORMANCE RATING

If filters are documented by performance rating to AS 1324.1 clause 2.1.1 conform to the following:

≥ 20% average efficiency when tested with AS 1324.2 Test Dust No. 1.

≥ 85% average arrestance when tested with AS 1324.2 Test Dust No. 4.

2.5.5 FILTER MEDIA

Provide filter media that does not shed fibres in services and nor support microbial growth and is resistant to fungal and vermin attack.

2.5.6 FLAT PANEL FILTER

The flat filter media shall be of disposable type and have a performance rating of G2 equivalent to 65-80% average arrestance to No.4 test dust in accordance with AS 1324.

The media shall be supported on both sides by wire grid constructed with no sharp edges or projections that can puncture or damage the media.

Maximum initial resistance when the filter is clean shall not exceed 25 Pa. at a gross face velocity of 1.8 m/s.

2.5.7 V FORM, PLEATED PANEL FILTER

The V form filter media shall be disposable type and have a performance rating of G4 (type 1) equivalent to >90% average arrestance to No.4 test dust or F5 (class B) equivalent to 40 to 60% average efficiency to No1 test dust in accordance with AS 1324.

The media shall be enclosed in a heavy duty die cut cardboard frame bonded to the media. The pleats in the media shall be formed by an expanded diamond metal or welded wire grid made of galvanized steel laminated to the air leaving side of the media.

Provide a rigid metal frame into which the medium is installed. Support the medium on the mounting frame to provide even air flow. Shape pre-formed media to fit the frame. Hold the medium in place with clips, tabs or similar devices so it does not move in service.

Maximum initial resistance when the filter is clean shall not exceed 75 Pa. at a gross face velocity of 2.5 m/s.

2.5.8 MARKING

Permanently and legibly mark, on a suitable section of the filter, the following:

1. Filter type and class.
2. Direction of airflow.
3. Proprietary type, model and serial number.
4. Filter performance rating to AS 1324.1.

2.5.8.1 Replaceable element

On the clean air side, fix the name of the supplier, proprietary type, filter type to AS 1324.1 and filter performance rating to AS 1324.1.

2.5.8.2 Plant room

Provide a permanent notice fixed to the wall identifying each filter and giving their design filter performance rating.

Ongoing purchasing requirements should require that replacement filters are labelled with the same performance ratings as the originals.

2.5.9 INSTALLATION GENERALLY

2.5.9.1 Attachment

Rigidly attach filter frames to the air handling plant casing (such as duct, or return air plenum) with a system of bolting or blind pop riveting. Locate bolts or rivets clear of the filter element. Do not fix to the casing insulation. Ensure that the installation of the filter does not reduce its rated performance.

Ensure that individual filter inspection and maintenance can be readily carried out without disturbing the filter bank.

Ensure that there are no leaks between the filter holding frame and the casing. Seal individual filter units to each other. Seal filter connections to adjoining equipment, panelling or supporting framing. Do not use adhesive tapes for sealing.

Do not use Slide-in filter units.

Provide a 50 mm high plinth below the filter bank.

2.5.9.2 Cell frames

Install filters so that they are accessible for maintenance and do not accumulate moisture.

Seal filter frames to the plenum or duct in which they are installed.

2.5.9.3 Blanking plates

Close gaps where the dimensions of the filter plenum do not match those of the framing. Seal air tight to ensure no air bypasses the filters.

Plates material: ≥ 0.8 mm metallic-coated steel or grade 304 stainless steel sheet.

2.5.9.4 Additional bracing

Provide stiffeners between or behind the joint of every second column along the narrowest dimension of the plenum.

Stiffeners: Fabricate from ≥1.6 mm metallic-coated steel or grade 304 stainless steel.

Maximum deflection of filter bank under operating conditions (ratio of deflection: height or width): 1:500 under maximum system final resistance.

2.5.9.5 Manometers

Provide a manometer on each filter bank with more than one cell or handling more than 600 L/s.

Type: Minimum 75 mm diameter non-liquid, diaphragm type marked to show differential pressure across each filter bank.

Differential pressure gauge unit: Include pipework, termination and fittings necessary for correct operation and maintenance.

Indicator scale: Mark in 10 Pa divisions with full scale deflection no more than twice the maximum dirty filter condition.

Location: Outside unit casing in a readily readable location.

Marking: Mark clean and maximum dirty pressure drops on manometer scale.

2.5.9.6 Temporary pre-filters

Provide sheets of filter media to protect filter banks at installation.

2.5.9.7 Filter banks

General: Provide holding frames.

2.5.9.8 Filter access platforms

Ensure that platforms and ladders do not obstruct filter access. Construct to AS 1657.

2.5.10 CLEANING

2.5.10.1 Cleaning

General: Before start-up, ensure that the installation is free from debris and dirt, and check the integrity of the filter bank and plenum installation.

2.5.10.2 Temporary pre-filters

Remove at completion of commissioning.

2.5.10.3 General Filter Schedule

Filters in air handling units and supply air systems greater than 1000 l/s shall be Deep Bed type with a minimum filter rating of F5 to AS 1324.1. [modify subject if FCU or AHU]

Filters in fan coil units and supply air systems less than 1000 l/s shall be V form pleated panel type or flat panel type with a minimum filter rating of G4 to AS 1324.1 [recommend F5 if static pressure is acceptable]

Filters in bulkhead low static, wall mounted type, ceiling cassette type air conditioning units and supply air systems less than 1000 l/s shall be flat panel type or proprietary type shall be G2/G3 rating to AS 1324.1.

2.6 FANS

2.6.1 GENERAL

All provided fans shall be in compliance with BCA Section J requirements. This worksection applies to all equipment which has fan components. Provide fans with capacities as listed in the *Schedule of Equipment* and as indicated in the Selection clause below.

2.6.2 SELECTION

Prior to fan ordering, provide all fan curve to the client's representative for approval.

Centrifugal fans: Provide fans selected so the air flow can be increased ≥ 5% above the rate in *Schedule of Equipment* as follows:

1. Against the corresponding increased system resistance as installed.
2. Without unstable operation.
3. By speed change alone.

Axial flow fans: Provide fans selected so the air flow can be increased ≥ 5% above the rate in *Schedule of Equipment* as follows:

1. Against the corresponding increased system resistance as installed.
2. Without unstable operation.
3. By pitch angle change alone.

Fans with variable speed drives:

1. All fans: Provide fans selected to operate at ≤ 50 Hz under all conditions.
2. Fans with belt drives: Adjust fan speed during commissioning for motor to operate at ≤ 50 Hz under all conditions.

Fans with multi-speed motors:

1. Two speed fans: Provide fans selected to perform both duties given in the *Schedule of Equipment.*
2. Fans with ≥ 3 speeds and single phase fans with adjustable speed control: Provide fans selected to achieve the duty stated in the Fan schedules at a speed ≤ 80% of highest speed.

2.6.3 SUBMISSIONS

Provide only fans type tested by a Registered testing authority. Submit evidence of type tests as follows:

Fan performance: To BS EN ISO 5801 or ISO 5801 or AS ISO 5801.

Fan sound power levels: To BS 848-2.6, BS EN ISO 5136 or ISO 10302.

Smoke spill fans: To AS 4429

2.6.4 MATERIALS

Galvanized steel components shall be hot dip galvanized in accordance with AS/NZS 4680.

Coating thickness and mass shall be in accordance with AS/NZS 4680 Table 1.

2.6.5 CENTRIFUGAL FANS – GENERAL PURPOSE

2.6.5.1 Casings

Construction: Welded steel scroll and side plates, reinforced to prevent flexing and drumming.

Split casing: If the fan impeller is more than 1200 mm diameter, provide a horizontally split casing.

Inlet bells: Removable, shaped for aerodynamically efficient air entry and close approach to impeller.

Access panels: Provide inspection/access panels to casings of fans with impellers ≥ 650 mm diameter. Seal panels airtight with neoprene gaskets.

Outlets: Provide flanged or spigoted outlets to suit connected ductwork or equipment.

Guards: For fans not connected to ductwork provide removable inlet guards, discharge guards or both.

Drain point: Where moisture is likely to enter or condense inside a fan provide a 25 mm drain point welded into base of scroll and stopped with non-ferrous screwed plug.

Minimum casings thickness table

Impeller diameter (mm)	Side plates (mm)	Scroll (mm)
≤ 450	2	1.6
> 450, ≤ 800	2.5	2
> 800, ≤ 1000	3	2.5
> 1000, ≤ 1500	3	3
> 1500	5	3

2.6.5.2 Bases

General: Form from fully welded steel sections integral with or bolted to casings.

Mounting brackets: Provide at least 4 height saving mounting brackets.

2.6.5.3 Impellers

Blade type: Backward inclined aerofoil or laminar single thickness type, flat or curved section, with non-overloading power characteristics. Type as stated in the *Schedule of Equipment*.

Provide the following impellers characteristics:

1. Statically and dynamically balanced.

2. Keyed to drive shafts by means of taper-lock fixing devices or taper keys.

3. For overhung driven fans > 1000 mm diameter, retained onto drive shafts by positive devices such as washers and set screws into tapped holes in shaft ends.

4. Countersink in shaft for tachometer.

2.6.5.4 Bearings

For single width fans with impellers < 1250 mm diameter and double width fans with impellers < 950 mm diameter: Provide pillow-block mounted, self aligning ball bearings, sealed for life, with a minimum rating fatigue life of 100 000 hours.

For single width fans with impellers ≥ 1250 mm diameter and double width fans with impellers ≥ 950 mm diameter: Provide plummer-block mounted roller bearings to , with seals and grease relief, with a minimum rating fatigue life of 100 000 hours. Extend grease nipples for ready access.

2.6.5.5 Motors

Provide electric motors that are compatible with fan requirements, providing efficient non-overloading fan units.

Motors power rating shall be adequately sized to allow flow to be increased by 5% above the specified design air flow rate, against the corresponding increased system resistance.

Supply thermistors on all motors sized 11 kW or greater.

Motor protection shall be minimum IP54.

2.6.5.6 Belt drives

Drive sizing: Size for ≥ 125% of motor power and capable of transmitting the full starting torque without slip.

Belts: Wedge belts to AS 2784, consisting of matched sets of at least 2 belts. Mark belt size in a prominent location on the fan casing.

Belt tensioning: Provide adjustment of belt drive tension by either movement of motor on slide rails or by pivoting support. Do not use the weight of motors to provide belt tension. Restrain motors with locknuts on bolts, clamping motors in place.

2.6.5.7 Drive shafts

Characteristics: Drive shafts shall be:

1. Designed so that the first critical resonant speed of the shaft is ≥ 130% of design maximum operating speed.

2. Double width fans with shaft diameter > 60 mm: Filleted stepped type to permit easy impeller removal.

3. Keyed with taper-lock fixing devices for fixing of pulleys.

4. Countersunk ends for tachometer application or, where the end of the shaft is not accessible, make provision for use of stroboscope or optical tachometer.

5. Material: Mild steel or high tensile steel, as appropriate for the duty. Provide corrosion protection by solvent removable petroleum based protective coating formulated for machinery shafts and parts.

2.6.5.8 Drive guards

Provide rigid, removable belt guards on all fans where drive is accessible while motor is running. Provide the following:

1. Tachometer opening.

2. Perforated sides on double width, double inlet fans.

3. Weatherproof construction, ventilated and drained where exposed to weather.

Material: Open mesh or perforated metallic-coated sheet steel.

2.6.5.9 Finishes

Prime all surfaces with zinc phosphate primer to AS/NZS 3750.20 and apply manufacturer's standard paint system to external surfaces.

2.6.6 CENTRIFUGAL FANS – SHEET METAL

2.6.6.1 General

To Centrifugal fans – general purpose except as varied in **Casing construction and Motors:**

2.6.6.2 Casing construction

Casing construction shall be metallic-coated steel sheet, riveted or spot welded with joints sealed.

Scroll: 1.2 mm minimum thickness.

Side plates: 2 mm minimum thickness.

Bases shall be formed from pressed metallic-coated steel sheets, bolted to casings. Provide at least 4 brackets for mounting.

Impellers type shall be backward or forward curved section, laminar or aerofoil as scheduled.

Impellers construction shall be extruded aluminium or metallic-coated steel blades secured between reinforced galvanized steel plates.

Bearings shall be self-aligning sealed for life ball or roller type.

Finishes shall be brush and prime spot welds with zinc-rich organic primer to AS/NZS 3750.9.

2.6.6.3 Motors

Minimum degree of protection: IP51.

2.6.7 CENTRIFUGAL FANS – IN-LINE

2.6.7.1 General

Provide fans with non-overloading power characteristics.

2.6.7.2 Construction

Casings: Rectangular or circular with spigot or flanges for duct mounting, with construction as follows:

1. Steel: Metallic-coated steel sheet, spot welded. Brush and prime spot welds with zinc-rich organic primer to AS/NZS 3750.9.

2. Glass reinforced plastic (GRP) or plastic: Moulded GRP or impact resistant plastic with integral support foot.

Impellers shall be backward inclined or forward curved style as scheduled, constructed from metallic-coated steel, extruded aluminium or polypropylene. Balance impellers statically and dynamically.

Motors shall be direct mounted to impellers with minimum Thermal class 155 (F) insulation to IEC 60085. Provide sealed for life bearings with a minimum rating fatigue life of 40 000 hours at 40^{o}C ambient.

For electrical connection, provide terminal box external to fan casing and wired to fan motor.

The access for fans with impellers < 350 mm diameter, provide fan manufacturer's standard fast clamps both sides of the fan to permit the impeller-motor assembly or fan as whole to be removed.

2.6.8 AXIAL FLOW FANS

Provide fans with non-overloading power characteristics.

2.6.8.1 Casings

Tubular, flanged at each end, constructed from mild steel, fully welded, hot dip galvanized after fabrication.

Provide access to the fan core as follows:

1. < 1000 mm diameter: Sight hole in casing plugged with an airtight removable closure.

2. ≥ 1000 mm diameter: Provide access panels, securely bolted to casings and sealed with neoprene gaskets, for maintenance.

2.6.8.2 Impellers

Provide aerofoil section blades constructed from cast aluminium alloy with manually adjustable pitch angle.

Balance impellers, statically and dynamically.

2.6.8.3 Unducted inlets/outlets

Provide aerodynamically shaped cones to inlets of fans.

Provide, at the outlets of the fans, manufacturer’s standard 15 conical diffuser to convert velocity head to static pressure.

Provide galvanized steel or bronze mesh guards.

2.6.8.4 Motors

Direct mount motors to impellers with minimum thermal Class 155 insulation to IEC 60085. Class 180 (or higher) insulation for smoke spill fans is required.

2.6.8.5 Bearings

Provide sealed for life bearings or grease packed bearings fitted with lubrication lines extending through the casing. Provide bearings with a minimum rating fatigue life of 100,000 hours, suitable for horizontal or vertical mounting as appropriate.

2.6.8.6 Electrical connection

Provide terminal box external to fan casings and wire to fan motors.

2.7 COIL PROTECTION

2.7.1 GENERAL COIL COATING

Coil requirements

1. Polyurethane coating impregnated with metallic pigment to prevent loss of heat conductivity.
2. Coil / heat exchanger fins shall be of an aluminium and/or copper construction with a protective coating applied after construction of the coil to achieve a total coverage.
3. The coating shall not block the possible fin perforations. Coating shall be repairable and maintainable on site.

Coating characteristics:

1. Coating shall be UV resistant, flexible, heat conductive, chemical resistant to most (aggressive) environments.
2. A resistance list must be available.

Application:

Due to the specialized nature of the corrosion protection system, it is essential that only a qualified applicator is contracted for this application. The entire unit shall be prepared in order to obtain access to the finned coils. Wiring and sensitive electrical components shall be protected during the cleaning and coating process. The most critical areas which have to be coated are the heat exchangers surfaces (finned coils). Protection against corrosion shall be achieved by means of a high pressure spray technique that ensures full penetration but prevents bridging (thus preventing capacity loss).
Copper elbows (returns), headers and brazing parts are pre-treated with special Polyurethane primer to ensure maximal adhesion and protection to these areas.

- **Quality level**

Quality level of the treatment should meet the following requirements.

- **Appearance Level**

The penetration of the coil has to be 100%, to be established and proven by the working method and visual inspection.

- **Adhesion Level**

The adhesion level should meet Cross hatch test level 0 (European) and 5B (USA) according to ASTM 3359-83 53151 method B-A

- **Thickness Level**

The thickness level should meet 1 mil (25 µm) plus or minus 20 %.

- **Corrosion Resistance Level**:
  ASTM-B117 (DIN 53167) 4000 hours
  Conditions:

- Salt concentration 5 % NaCl
- pH 6,5 - 7,2
- Temperature 37°C (98,5°F)

ASTM-B287 (DIN 50021) 4000 hours
Conditions:

- Salt concentration 5 % NaCl
- pH 3,2 by Acetic Acid (HAc)
- Temperature 37°C (98,5°F)

A Certificate of Completion from the applicator is required upon completion to ensure that the specifications have been adhered to.

SECTION 3 - DUCTWORK AND ASSOCIATED FITTINGS

3.1 EXTENT OF WORK

All ductwork must be supplied and installed, as specified, in compliance with AS4254 (AS4254.1 for flexible duct and AS4254.2 for rigid duct), NCC/BCA Section J Ductwork sealing clause and as shown on the drawings.

The ductwork layout as shown on the drawings is approximate only. The sub-contractor shall generate shop drawings that are fully co-ordinated with other trades and the site conditions. The final duct arrangement shall be installed on site as per the sub-contractor's Shop Drawings.

3.2 RECTANGULAR METAL DUCTWORK

Duct material shall be zinc-coated steel sheet, coating class G2/Z275.

Sheet thickness shall be in accordance with AS4254. Duct shall be cross broken or beaded as necessary and in accordance with AS 4254 in the exception of kitchen exhaust ducts – refer to clause Kitchen Exhaust Ductwork in this specification if applicable.

Joints and ductwork sealing shall be in accordance with AS4254.

3.3 FLEXIBLE DUCTWORK

Flexible duct insulation shall be in accordance with BCA Section J.

Duct material shall be in compliance with AS 1668.1 in regards to toxic emissions and fire hazard properties.

Insulated ducts shall be used in the supply and return air and the duct material shall be aluminiumised fabric with external metal helix, factory faced externally with 25mm thick fibreglass and sleeved with perforated aluminium laminate or polythene. The duct shall have a 0,0,0,3 fire rating as defined by AS1530 Part 3.

Uninsulated ducts can only be used in exhaust systems and duct material shall be aluminium foil laminate with galvanised steel wire helix that forms a continuous flexible tube able to resist permanent deformation. The aluminium foil laminate reinforcement shall provide a high resistance to tearing and puncturing.

Maximum flexible duct length shall be 6m, in a single duct piece. No joints between lengths of flexible duct shall be accepted.

Spigots, for the connection of flexible ducts to rigid ducts, shall be circular or oval rigid to suit the size of the flexible duct. Spigots shall be fitted with butterfly damper and a bell mouth shape at point of take off. The damper shall be complete with a metal shaft securely fixed to the blade and a cast metal quadrant arm. The quadrant arm shall clearly indicate the damper position and shall be secured to a cast metal quadrant by a wing nut. The quadrant shall be mounted clear of the duct insulation.Connect the flexible duct over the spigot with a minimum of 100mm overlap, and seal using approved Cheney type hose clip sealing band. The use of tape only shall not be accepted. Flexible duct sealing shall be in accordance with AS4254.

Install flexible duct as straight as possible with minimum number of bends. Support properly and limit sag to < 40 mm/m.

3.3.1 TYPICAL ACOUSTIC PERFORMANCE FOR ACOUSTIC FLEXIBLE DUCT

All flexible ducts provided must be acoustic type flexible ducts.

Typically a 3m length of ∅200 duct shall have an insertion loss of:

H_z	63	125	250	500	1k	2k	4k
DB	12	26	38	27	18	19	25

3.4 FLEXIBLE CONNECTORS

Ductwork shall be connected to vibrating equipment such as fans and conditioner casing with an air tight flexible connecting sections in accordance with AS 4254 and a minimum 100 mm length.

Flexible connections shall comply with the requirements of AS 1668.1 and materials used shall be heavy duty, waterproof, and have the same fire rating as the duct.

Openings of connected equipment shall be aligned and the flexible connector shall be provided with sufficient slack to ensure free movement and vibration isolation under operating and static conditions.

Flexible connection shall be fixed to duct and equipment with zinc-coated steel strip and shall not protrude into the airstream. The joints shall be sealed. The flexible connection installation shall be arranged to permit easy replacement without affecting the connected equipment. Flexible connectors shall not be painted.

3.5 ACCESS PANELS/DOORS IN DUCTWORK

Provide access panels in ductwork at all fire dampers, heating coils, at 3m intervals in non-filtered outside air ducts and access doors to air handling units, as appropriate, and as generally indicated on the drawings, for easy and safe access to and about all plant equipment and components, for cleaning, inspection and maintenance in accordance with the requirements of AS/NZS 3666.1 and AS/NZS 3666.2 and sized as follows:

1. minimum 450 x 600mm for man access
2. minimum 200 x 300mm for hand access
3. minimum 1.35m high x 600mm width for door access to air handling units

Provide access hatches, access panels and/or hinged and latched access doors wherever appropriate and next to each component located inside the duct requiring regular inspection and maintenance including, but not limited to:

1. Fire dampers.
2. Smoke detectors.
3. Filters.
4. In the vicinity of moisture producing equipment.
5. In other locations documented.

Panels shall be sandwich type double panel, deep formed zinc-coated steel construction, insulated to match the duct, or filled with at least 25mm mineral wool insulation.

Provide rigid matching galvanized steel frames securely attached to the duct. Do not allow any part of the frame to protrude into the airstream.

Seal edges of panels with silicone rubber or soft neoprene gaskets mechanically fixed to either the panel or the frame to ensure an airtight seal when latched in the closed position. For fire rated seals, provide woven ceramic fibre material.

Provide wedge type sash latches. For man access panels provide a minimum of 4 per panel. For hand access panels provide a minimum of 2.

The access doors to air handling units shall be reinforced to minimise distortion, and hinged so that internal air pressure holds doors closed. Provide proprietary clamping-type latches and handles which can be operated from both the inside and the outside of the door.

3.6 INSTALLATION OF DUCTWORK

Ductwork shall be arranged, as far as possible, in parallel to each other and to building structure in an orderly manner. Provide adequate access to ductwork components which require inspection, maintenance and repairs.

3.6.1 SPACING, SUPPORTS AND HANGERS

The minimum clear spacing in addition to duct insulation shall be as follows:

1. 25mm between adjacent ducts and also between duct flanges or upper surfaces of ducts, and undersides of beams and slabs.

2. 50mm between ducts and electric cables.

3. 150mm between ducts and ground, below suspended floors.

Support ductwork off building structure only. Hangers shall be provided at regular intervals to support ductwork.

For vertical ducts, use galvanized steel angles, of minimum size 50mm x 50mm x 5mm, secured to masonry walls.

Galvanised steel trapeze type hangers shall be provided for rectangular ducts in the horizontal runs.

Steel strap bracket under the duct, bolted at top or side of duct and supported by mild steel rod or flat strap shall be provided for circular ducts.

Insulation and vapour seals shall not to be crushed or damaged. Accordingly, enough space between hanger rods and duct shall be allowed and galvabond spreader plate between insulation at bottom of duct and hanger bracket shall be provided.

Fix hangers to the side of the ducts using bright zinc-plated self drilling and self tapping screws or properly sized expanding solid end type rivets. Washers shall be provided under all nuts and bolt heads.

3.6.2 TEST POINTS, VIBRATION AND CLEANING OF DUCTWORK

Provide a sufficient number of sets of suitably sized and located holes in ductwork for testing and balancing of the system. Locate holes in straight lengths of duct for more accurate measurement. Where practical allow a minimum of 10 equivalent diameter of straight duct up stream and a minimum of 1.5 equivalent diameters downstream. Seal with rubber grommets in low pressure ductwork. Seal with cover plates in medium and high pressure ductwork.

Provide additional supports, as required, to prevent vibration in ductwork when the system is in operation.

Continuously remove all foreign debris from inside the ductwork during installation.

3.6.3 DUCTWORK EXPOSED TO WEATHER

Ductwork must be water-tight and all joints sealed to prevent water entering the duct. The topside of the duct shall be crowned to allow water runoff and the duct side shall be cross-broken between the corners and the crown. Stiffening angles on topside of the duct shall be bent to follow the set of the crown. Covers shall be provided to ductwork flanges.

Ductwork shall be installed angled to one side to prevent pooling of rainwater or alternatively cross broken rain covers will be provided.

3.7 DAMPERS

3.7.1 VOLUME CONTROL DAMPERS (VCD)

The face dimensions of the VCD shall be full duct size and shall be provided free of rattle, flutter or slack movement. The VCD shall be capable of adjustment over the necessary range without excessive self-generated noise or the need for special tools.

Material and Construction

Frames material shall be 1.6 mm minimum thickness zinc-coated steel or 2 mm minimum thickness aluminium folded to form channel sections at least 150 mm wide and welded at corners.

Blade material shall be 1.2 mm minimum thickness zinc-coated steel or 1.8 mm minimum thickness stainless steel.

VCD shall be multi-blades type damper. Single blade dampers may be used for 300mm x 300mm or 300mm diameter in size and smaller sizes.

Multi-blade dampers shall have 175mm wide blades and shall not exceed 1200mm in length. For multi-blades dampers with a length exceeding 1200 mm, provide intermediate mullions.

VCD connection to the duct shall be mating angle flanged cross joints.

Spindle shall be 10 mm diameter bright zinc-plated steel for blades lengths less than 600 mm and 12 mm diameter bright zinc-plated steel for blades lengths greater than 600 mm.

Bearings shall be riveted to damper frame and shall be oil impregnated sintered bronze ball bearings type. Engineering plastic sleeve type bearings may be used if operating temperature is equal or below 50°C.

Linkages shall be securely fixed to blades to force the blades rotate equally and close tightly without slip.

Handle for adjusting the damper and locking it in position shall be provided and shall be located in an accessible position. After balancing the system, the balancing devices shall be locked. The open, closed and balanced positions of the damper shall be permanently labelled and clear to interpret.

Locate dampers such that they shall be readily accessible for inspection and maintenance. Where this is not possible provide access panel.

3.7.2 SPLITTER DAMPERS

Limitation: Use only on supply ducts and only if duct velocity is less than 10 m/s. Provide volume control dampers otherwise.

Push rods: 5 mm diameter on 600 mm centres with screw locking bushes to fix position and located in an accessible location.

3.7.3 NON-RETURN DAMPERS

Non-return dampers shall comply with the clause *Volume Control Dampers* elsewhere in this specification.

Non return dampers shall only be used on applications involving <0.25 m_2 airway cross section, otherwise motorised tight shut off dampers shall be used.

Counterweight the assembly so that it offers minimum resistance to air flow; and closes by gravity to give minimal leakage back through the damper.

Where dampers are installed in sheet metal ductwork, access panels shall be provided to give access to the counterweights and pivots for adjustment and inspection.

3.7.4 FIRE AND SMOKE DAMPERS

Fire and smoke dampers shall be supplied and installed in compliance with AS1682.1 and 2. Fire dampers may be of mechanical or intumescent type and shall be selected to suit the size of the opening.

Provide connected ductwork and insulation where required by AS1668.1 to achieve required FRL insulation of the building element.

Submit test certificates to the client's representative showing compliance with AS1682.1 for air leakage and fire resistance.

Test mechanical type fire dampers during commissioning to ensure fire dampers close fully with fans operating.

3.8 DIFFUSERS AND AIR GRILLES

3.8.1 GENERAL

Diffusers and air grilles shall be proprietary units and materials shall be aluminium or steel with a powder coated finish.

Diffusers and air grilles shall be coordinated with the ceiling arrangement and ceiling suspension system and shall be provided without any distortion, irregular joints, surface scratches or defects, bends, visible fastenings and vibration during operation.

Diffusers and air grilles shall be mounted with concealed and secure fixings with all flanges lining corners tidily finished with no joint gaps. The border frame to each ceiling located air terminal fitting shall be such that it fits the ceiling tile/suspension system.

For variable air volume diffuser applications provide grilles tested for this application.

Integral volume control dampers shall be provided where suitable for the application and shall be manually adjustable through the grille face with allen key or similar.

All visible internal surfaces shall be finished matt black.

Test certificates to BS 4773:2 shall be provided for generated noise levels for air diffusion devices.

Supply air outlets shall be selected and sized to achieve a maximum air speed of 0.25 metres per second at occupant level of approximately 1.5 metres from floor level.

The air flow rate to the diffusers to be controlled by a damper located at the flexible duct connection to the main ductwork unless otherwise nominated on the drawings.

3.8.2 LOUVRE CEILING DIFFUSERS

Louvred ceiling diffusers shall be multi-bladed of extruded aluminium construction with removable core. Removable core shall be of the 4-way blow configuration fitted with a blanking plate for 1, 2 or 3-way blow as indicated on the drawings.

Diffusers face sizes shall be as nominated on the drawings. Provide a reducer neck if the diffusers neck is smaller than the outlet necessary to suit the diffuser face size.

3.8.3 CEILING TWISTED DIFFUSER

Radial twist outlet constructed in sheet steel with either a circular or square visible configuration to generate symmetrical radial jets with horizontal discharge pattern.

3.8.4 RETURN / EXHAUST GRILLES

Refer to the drawings for the nominated type of return and exhaust grilles.

Eggcrate exhaust air grilles shall of aluminium construction. The eggcrate core shall be removable type and shall be 12.5mm x 12.5mm x 12.5mm Elements at 90^{o} to each other and fitted in extruded aluminium Flanged Frame.

Full Chevron Blades set at 25mm centres in flanged frame suitable for wall or ceiling installation and shall be of extruded aluminium construction and finished in powdercoat. Minimum free area shall be 60%.

Louvres type shall be with 45 Degree Blades set at 25mm Centres in Flanged Frame suitable for wall or ceiling installation and shall be of extruded aluminium construction and finished in powdercoat.

3.8.5 INSTALLATION

Protection wrapping shall be left in place until final mounting.

Mounting

General: Provide a matching escutcheon to close gaps between the grille and its surrounds. Provide grilles with flanges to cover penetrations and irregularities in surrounds.

Tiled ceilings: Locate grilles and diffusers to minimise cut tiles. Otherwise, locate grille symmetrically in the tile.

Appearance: Install square.

Fixing

Visibility: Provide concealed fixings.

Accessibility: Provide fixings which allow removal without damage to surrounds or outlets.

Gaskets: Provide foam type gaskets under outlet flanges or flanged supports.

3.8.6 CUSHION HEAD BOX (PLENUM BOXES)

Provide cushion head boxes for all diffusers connected to flexible ductwork. Side entry on the cushion head boxes for the flexible duct connections shall be round or oval spigot.

Cushion head boxes shall be supported from above and independently of the ceiling or from the ceiling main Tees provided the load is less than the ceiling system manufacturer's maximum.

Cushion head boxes shall be provided with black matt internal insulation to match connecting duct system insulation requirements.

SECTION 4 - MECHANICAL PIPING, VALVES AND ASSOCIATED FITTINGS

4.1 GENERAL

Provide piping systems complete with all necessary piping, valves, supports, guides, drains, vents, expansion compensation and all fittings necessary for their safe and efficient operation.

Erect piping systems following the line of walls, ceilings, structure, etc., and include all necessary offsets and arrange to avoid interference with the building or other services regardless of whether or not these aspects are shown on the drawings.

Base design pressures for the entire system on the more onerous of either of the following:

1. The maximum hydrostatic head at the location; plus the pump shut off head at the maximum impeller size for the pump casing

2. or 600 kPA

Make provision for plant isolation and access for maintenance. Locate valves and other components in ceilings where they are easily accessible and where access or leaks will not cause inconvenience or risks to occupants, or damage to water sensitive equipment.

Arrange connections to plant to permit dismantling of the plant without disturbing other pipes and to permit removal of the plant without removal of the piping. Provide union on at least one side of each screwed valve and screwed pipeline component requiring removal for inspection or maintenance.

Make all connections to plant by one of the following methods:

1. Flare compression joints (up to 20 mm copper and only where there is no vibration).

2. Screwed brass unions (up to 50 mm size and for pressures up to 800 kPa).

3. Bolted flanges (no limitation).

Where fittings are of different material to the pipe, provide suitable water treatment and separation to prevent galvanic corrosion.

Submit detailed piping layouts, coordinated with the building structure and other trades, and a complete schematic to the client's representative for approval before commencing the piping installation. Submit samples of proposed support system, and manufacturers' information on all pipe types and fittings including the following:

1. Calibrated balancing valves: For each type and size of valve, submit a manufacturer's calibration chart relating pressure drop to fluid flow across the valve opening range. Submit independent test reports giving accuracy and repeatability tolerances.

2. Automatic/dynamic system balancing valves: For each type and size of valve, submit a manufacturer's report verifying a flow rate control accuracy of ± 5% or better is maintained over the selected pressure differential control range.

4.2 PIPING MATERIAL SCHEDULE

Provide pipe systems of the following materials. Materials shall comply with the clause *Piping Materials Standards* elsewhere in this specification:

4.2.1 CONDENSATE DRAINS

Copper to AS1432 Type B,

or UPVC for condensate drains only.

4.2.2 REFRIGERATION PIPEWORK

Refer to Refrigeration Piping clause in this section of the Specification. In general, refrigerant pipework shall be Copper to AS1571 (Refrigeration Code) and AS1135 (Non-ferrous Piping Code).

4.3 PIPING MATERIAL STANDARDS

4.3.1 COPPER PIPING

Copper pipes shall be in compliance with AS1432 type B, hard drawn.

Installation shall be in accordance with AS 1135 (Non ferrous Piping Code).

Jointing

Select from the following except where a specific jointing method is documented:

1. Silver brazed capillary joints.

2. Brass flanges with brass nuts and bolts.

3. Flare compression joints: ≥ 20 DN nominal size and only where no vibration occurs.

4. Proprietary grooved joints.

Fittings

Capillary fittings including adaptor capillary fittings with threaded ends or compression-type connector ends: To AS 3688, of copper or dezincification-resistant copper alloy.

Compression fittings including adaptor compression fittings with connector-ends for screwed or capillary joints: To AS 3688, flared type, of copper or dezincification-resistant copper alloy.

Unions: Bronze, proprietary manufacture, with ground or accurately machined face joints.

Flanges: Brazing metal to AS 2129.

Demountable joints: Expand pipes into flanges and braze.

Permanent joints

Provide brazed slip joints. Provide either capillary fittings, or expand one pipe over the other leaving a minimum clearance and an effective overlap as per table below.

Slip joint overlap table

Nominal pipe size, DN	Overlap (mm)
≥ 15, < 20	12
≥ 20, < 32	15
≥ 32, < 50	25
≥ 50, < 80	30
≥ 80, < 125	35
≥ 125, < 200	40

4.3.2 PVC PIPING

Standards

Unplasticised pipes and fittings (PVC-U): To AS/NZS 1477.

Oriented PVC (PVC-O) pipes: To AS/NZS 4441.

Solvent cement: To AS/NZS 3879.

Installation

Standard: To AS/NZS 2032.

Jointing

Permanent joints: Solvent cement.

Demountable joints:

- Piping ≤ DN 50: Threaded fittings.
- Piping > DN 50: Flanges with backing rings.

4.4 VALVES, SAFETY TRAY, CONDENSATE DRAINS AND FITTINGS – GENERAL

4.4.1 VALVES AND FITTINGS

Components

Valve size: Generally at least the nominal pipe size, unless a smaller size is necessary for throttling purposes or flow measurement.

Insulated valves: Provide extended shafts or bodies to butterfly and ball valves to allow full thickness of insulation without restricting movement of hand-wheel or lever.

Automatic control valves: Conform to the Automatic controls worksection.

Connections:

- Valves ≤ DN 50: Screwed to AS ISO 7.1.
- Valves > DN 50, valves in headers: Flanged to AS 2129

Handwheels and handles: Removable, with the direction of closing marked permanently on handwheels.

Copper alloy valves: Dezincification resistant and stamped accordingly.

Valves for water circuits open to air including open condenser water circuits: Body bronze for sizes ≤ DN 50.

Installation

Valves: If practicable, install with the stem horizontal.

Non-return valves: Provide at least 6 pipe diameters of straight pipe on the upstream side.

Flow measuring valves: Install with pressure tappings accessible.

Valve Identification

General: Tag all valves and flow measuring devices for identification purposes. Provide a circular brass disc attached to the valve by a stainless steel wire drawn through the holes in the disc on each valve provided with operating handwheel or lever stamp the valve identification mark on the disc in characters 10 mm high.

Valves without operating handwheels: Mark by aluminium or brass strap 20 mm wide by 90 mm long stamped in the same manner as the valve identification discs. Attach by wire to the body of the valves.

4.4.2 CONDENSATE DRAINS

General

Provide trapped condensate drain lines with uniform and continuous fall to connect condensate trays to the nearest building drain point.

Provide drains from:

- Each indoor coil

- Each outdoor coil
- Each safety tray
- Other moisture collecting areas.

Material:

- Copper: To AS 1432 Type B.
- PVC-u: To AS/NZS 1477, installed to AS/NZS 2032.

Size: The greater of unit drain connection size and DN 20.

Pipe support spacing: To AS/NZS 3500.1 Table 5.2.

Sealing: Seal drain pipes where they penetrate casing.

Termination: Terminate drains to enable visual inspection of condensate flow.

Traps: To withstand > 2 times fan static pressure and constructed from either:

- Transparent, kink resistant hose.
- PVC-u trap with removable caps and a visible air break.

Falls and drains: Check that the condensate tray falls comply with AS/NZS 3666.1 and in particular that trays and sumps are graded to the outlet to prevent moisture retention. Test drains by pouring a measured quantity of water into upstream end.

4.4.3 SAFETY TRAY

Location

Provide a safety tray under packaged unit and indoor unit of split systems if leaks or condensation from these could cause nuisance or damage to the building or its contents.

Construction

Galvanized steel sheet, 1.2 mm thick folded and stiffened, edges turned over and with all joints sealed. Sides ≥ 50 mm high.

Extend tray ≥ 150 mm beyond unit casing and any components that may leak or drip condensation.

Drainage: Provide fall in tray and provide drain at lowest point. Run drain to visible waste.

4.5 REFRIGERANT PIPING

Conform to equipment manufacturer's recommendations for the refrigerant used. Provide refrigeration piping designed and installed so that the complete system meets the documented performance under the documented operating conditions.

Design

Suction lines: Size for pressure drop < 1.0 K saturated suction temperature at documented supply air flow, documented cooling coil entering conditions, documented condenser air entering condition and unit manufacturer's rated total capacity, saturated condensing temperature and saturated suction temperature under the above conditions.

Oil return: Size for oil return to compressor. Where velocity for oil return would result in the suction line pressure drop exceeding pressure drop limit, provide double suction risers. Prevent oil draining back on the off cycle.

Liquid lines: Size for pressure drop < 1.0 K saturated liquid temperature when handling the manufacturer's unit capacity under the operating temperatures stated in the schedules.

Layout

General: Install pipework in straight lines and uniform grades without sags. Grade horizontal hot gas lines and suction lines at not less than 1 in 200 in the direction of gas flow.

Location: When possible, run suction and liquid lines inside common insulation.

Pipe Support

General: Provide hangers, brackets, saddles, clips, and support system components, incorporating provisions for adjustment of spacing, alignment, grading and load distribution. Support pipework from associated equipment or building structure. Support valves, strainers and major line fittings so that no load is placed on adjacent tubes or transmitted to them during operation and maintenance.

Support type: Proprietary metallic-coated steel channel section with clamps and hangers sized match external diameter of pipe being supported.

Vertical pipes: Provide anchors and guides to maintain long pipes in position, and supports to balance the mass of the pipe and its contents.

Saddles: Do not provide saddle type supports for pipes ≥ DN 25.

Uninsulated pipes: Clamp piping supports directly to pipes.

Insulated pipe support:

- Spacers: Provide spacers at least as thick as the insulation between piping supports and pipes. Extend either side of the support by at least 20 mm.
- Spacer material: Rigid insulation material of sufficient strength to support the piping and suitable for the temperature application.
- Vapour barriers: For cold pipes apply aluminium foil tape over the circumference of the spacer to form a vapour barrier.
- Metal sheathing: Provide a 0.55 mm thick metallic-coated steel band between the aluminium foil tape and the support, for the full width of the spacer.

Pipe support spacing table

Nominal pipe size, DN	**Maximum spacing (m)**	
	Horizontal	**Vertical**
10	1	2
≥ 15, ≤ 20	1.5	2.5
25	2	3
32	2.5	3
40	2.5	4

Nominal pipe size, DN	Maximum spacing (m)	
	Horizontal	Vertical
50	3	4
65	3	4

Pipes

Piping: Provide copper tubes as follows:

- ≤ DN 20: To AS/NZS 1571, 0 temper.
- DN 20: To AS/NZS 1571 1/2H temper. Use annealed (0 temper) copper only for pulled bends.

Pipe wall thickness:

- Pipes ≤ DN 50: To AS 1432 Type B.
- Pipes > DN 50: ≥ 1.6 mm.

Deemed to comply for split systems under 7.5 kW cooling capacity: Split system manufacturer's standard pre-charged piping kit.

Bends

Pulled bends: Form bends without flattening or wrinkling with an inside radius ≥ 3 pipe diameters using the correct tool size for the pipe diameter.

Pipe fittings

Copper alloy fittings: To AS 3688, dezincification resistant, welded, brazed or compression type only.

Preformed fittings: Preformed refrigerant capillary line tees, bushes, couplings and elbows. Wherever possible, make reductions at elbows, tees, line devices or equipment connections with reducing fittings, otherwise provide reducing bushes or reducing couplings.

Compression fittings: Flareless twin ferrule, torque free, mechanical grip fittings which can be gauged using a precision ground and hardened metal gap inspection gauge.

Screwed joints: Use only if equipment items are not available with flare, flanged or brazed capillary connections.

Brazed joints

General: Provide preformed capillary fittings or form capillary unions by expanding one pipe end. Prevent flux and brazing alloy from entering pipes. Use dry nitrogen to purge air from pipes before brazing. During brazing, maintain a flow of dry nitrogen through pipes to prevent oxidation.

Brazing alloy: To AS/NZS 1167.1 Table 2 alloy B4 ≥ 15% silver content.

Brazing alloy for jointing dissimilar metals: To AS/NZS 1167.1 Table 1 alloy A18 or an alloy with an equivalent silver content (≥ 34%) and impurity levels.

Sleeves

General: Provide pipe sleeves where pipes pass through building elements.

Valves

General: Provide valves of the type and in the location recommended by SAA HB 40.1. Make provision for charging and withdrawal of refrigerant. If a gauge is not permanently connected (for example commissioning connections), seal the outlet of the isolating valve with a flared seal cap nut.

Valve types

Service valves: Backseating type with gasketed cap.

Solenoid line valves: Solenoid coil and valve parts replaceable without disturbing valve body or refrigerant piping.

4.6 INSTALLATION

4.6.1 INSTALLATION – GENERAL

Arrangement

Changes of direction: Provide long radius elbows or bends where practicable, and swept branch connections. Provide elbows or short radius bends where pipes are led up or along walls and then through to fixtures. Do not provide mitred fittings.

Installation

General: Install piping in straight lines at uniform grades with no sags. Arrange to prevent air locks. Provide sufficient unions, flanges and isolating valves to allow removal of piping and fittings for maintenance or replacement of plant.

Arrangement: Arrange and support piping so that it remains free from vibrations whilst permitting necessary movements. Minimise the number of joints.

Spacing: Provide at least 25 mm clear between pipes and between pipes and building elements, additional to insulation.

Dissimilar metals: Join dissimilar metals with fittings of electrolytically compatible material.

4.6.2 ACCESSIBILITY

General

General: Provide access and clearance at fittings which require maintenance or servicing, including control valves and joints intended to permit pipe removal. Arrange piping so that it does not interfere with the removal or servicing of associated equipment or valves or block access or ventilation openings.

Gauges

General: Locate thermometers, pressure gauges and similar instruments so that they are easily read after installation.

4.6.3 CLEANING

External preparation

General: Remove scale, rust, burrs and grease and ensure that surfaces are clean and dry.

Protection: During construction, prevent the entry of foreign matter into the piping system by temporarily sealing the open ends of pipes and valves with purpose-made covers of pressed steel or rigid plastic.

4.6.4 SUPPORT

Support systems

General: Provide hangers, brackets, saddles, clips, and support system components, incorporating provisions for adjustment of spacing, alignment, grading and load distribution. Support pipework from associated equipment or building structure. Support valves, strainers and major line fittings so that no load is placed on adjacent tubes or transmitted to them during operation and maintenance.

Support type: Proprietary metallic-coated steel channel section with clamps and hangers sized to match external diameter of pipe being supported.

Vertical pipes: Provide anchors and guides to maintain long pipes in position, and supports to balance the mass of the pipe and its contents.

Saddles: Do not provide saddle type supports for pipes ≥ DN 25.

Dissimilar metals: If pipe and support materials are dissimilar, provide industrial grade electrically non-conductive material securely bonded to the pipe to separate them. Provide fixings of electrolytically compatible material.

Uninsulated pipes: Clamp piping supports directly to pipes.

Insulated pipes:

- Spacers: Provide spacers at least as thick as the insulation between piping supports and pipes. Extend either side of the support by at least 20 mm.
- Spacer material: Rigid insulation material of sufficient strength to support the piping and suitable for the temperature application.
- Vapour barriers: For cold pipes apply aluminium foil tape over the circumference of the spacer to form a vapour barrier. Fit to spacer before installation of the bracket on the pipe.
- Metal sheathing: Provide a 0.55 mm thick metallic-coated steel band between the aluminium foil tape and the support for the full width of the spacer.

Support spacing

Ferrous pipes: To AS 4041 Table 3.28.2.

Copper pipes: To AS 4809 Table 6.2.

Other non-ferrous pipe: To AS/NZS 3500.1 Table 5.2.

Hanger size table

Outside diameter of pipe or sheathing (mm)	**Minimum hanger diameter (mm)**	
	Light series	**Heavy series**
< 20	6	6

Outside diameter of pipe or sheathing (mm)	Minimum hanger diameter (mm)	
	Light series	Heavy series
≥ 20, < 35	10	10
≥ 35, < 65	12	12
≥ 65, < 120	12	16
≥ 120, < 220	16	16
≥ 220, < 275	16	20
≥ 275, < 325	20	24
≥ 325, < 410	24	30

4.6.5 FLEXIBILITY

General

Provide pipe anchors offsets or expansion devices and pipe guides which accommodate expansion and contraction, and minimise the transmission vibration and noise to building structures. Locate anchors and guides at equal distances on each side of expansion devices. Weld or securely clamp anchors to bare pipe. If limitations in the strength of structures prevent the use of expansion devices and anchors, arrange piping to move in lateral and linear directions (e.g. at bends) while not deviating from gradients.

Flexible connections

Minimise the transmission of vibration and noise through the piping. Provide flexible connections between piping and vibrating sources.

Connections to major plant items: Reinforced rubber type, spherical shape with flanged ends.

Elsewhere: Flexible reinforced nylon hose.

4.6.6 SLEEVES

General

Location: Provide sleeves that permit normal pipe movement through all walls, floor slabs, and building elements.

Cover plates

General: Where exposed to view provide cover plates fixed to the pipe or insulation sheathing and free to move with respect to sleeve and building surface.

Material: Non-ferrous metal, finished to match the pipe, or of stainless steel, close fitting and firmly fixed in place.

Cover plate sizes table

Nominal pipe size, DN	Cover plate diameter
< 20	65 mm
≥ 20, < 50	100 mm
≥ 50	50 mm larger than pipe

4.6.7 JOINTS

General

Minimise the number of joints. If practicable, provide welded or brazed joints or a proprietary pipe coupling system.

Demountable joints

Provide demountable joints as follows:

1. At connections to mechanically cleanable heat transfer vessels and pumps.
2. At maintenance locations.

Pipes > DN 50: Flanged type.

Flanged joints

Metal flanges: Full face flanges with undistorted machined joint faces, to AS 2129.

Minimum flange thickness: 12 mm.

Bolting: To AS 2129 Appendix C and AS 2528.

- Material:
  - Non corrosive environments: Zinc-plated steel.
  - Corrosive environments: Material with equivalent corrosion resistance to, and compatible with, the flanges.

Flange jointing material: Preformed proprietary type at least 0.8 mm thick.

Installation: Install flanges square with the run of pipe and aligned parallel to each other. Do not correct misalignment by bolting.

Screwed joints

General: To AS ISO 7.1. Do not provide longscrews or barrel nipples. Seal threads of screwed connections with degreased PTFE tape or a thread sealing compound.

4.6.8 DRAINS AND GRADING

Drains

Water systems: Provide valved drains to the bottom of riser piping and as necessary to drain liquids completely from piping.

Other drains: Provide drains to drip trays, automatic air vents and equipment with drain points.

Drain size: Minimum DN 20. Match equipment drain size if larger.

Drain points: Pipe drains to discharge points via air breaks.

Air inlet vents: Provide at high points in the system.

Drain size table

Nominal size of pipe to be drained, DN	**Nominal size of drain and valve, DN (minimum)**
> 50, ≤ 100	20
> 100, ≤ 150	25
> 150, ≤ 300	32
> 300	50

Grading

Water systems: Grade to rise in the direction of flow to points of air venting, except, if the water piping is exposed in a run with other services, run the water piping to the same grade as the other services.

- Minimum grade: 1 in 200.

4.6.9 COMPLETION

4.6.9.1 Internal Cleaning

Each piped system shall be flushed out to remove pipe debris and any foreign material, prior to testing. Remove and clean strainers, as necessary, during flushing out procedures.

Repeat flushing out procedure until drain water runs clear.

4.6.9.2 External Cleaning

Remove scale, rust, and grease and ensure that surfaces are clean and dry, prior to painting or installation of insulation.

Paint and insulate the pipework systems in accordance with the relevant clauses elsewhere in this specification.

4.6.9.3 Pressure Testing

Refrigerant Piping

Pressure test to AS1677 prior to charging with refrigerant.

SECTION 5 - INSULATION

5.1 GENERAL

Insulate equipment, ductwork, cushion boxes, fittings and piping as specified below and as shown on the drawings. All insulation must be provided in compliance with BCA Section J requirements.

Insulating or acoustical materials including adhesives and protective coatings or wrappings used within ductwork, shafts, attenuating chambers and the like shall not give off toxic emissions under conditions of fire or intense heat and shall have early fire hazard properties not exceeding the following indices when tested in accordance with AS/NZS 1530.3:

- An ignitability index 0;
- A spread of flame index 0;
- A heat of flame index 0;
- A smoke developed index 3;

All insulating material and adhesives are to be of a type acceptable to the Authority having jurisdiction.

Ensure all insulation is of first grade standard with regard to design and manufacture and completely satisfactory under all conditions of service.

Ensure all adhesives, vapour coatings and sealers are selected and applied in accordance with the manufacturer's recommendations for the application to give a permanent bond and/or seal under all conditions of installation and operation.

Submit samples of insulation materials, adhesives, vapour barriers and details of fastening methods, for each type of pipe and duct insulation and obtain approval for same prior to commencing work.

5.2 INTERNAL INSULATION OF DUCTWORK AND ASSOCIATED FITTINGS

5.2.1 GENERAL

Insulate all ductwork and fittings including cushion boxes within the systems. Insulation thicknesses shall be in compliance with BCA section J or as per the acoustic requirement. . All associated Fittings, including cushion boxes, shall be insulated to the same insulation requirement as its associated ductwork.

5.2.2 MINIMUM INSULATION THICKNESS

	Climate zone 1-7	Climate zone 8
Ductwork & Fittings within conditioned space	R1.2 or 50mm	R2 or 75mm
Ductwork & Fittings within non-conditioned space	R2 or 75mm	R2 or 75mm
Ductwork & Fittings exposed to external & direct sun	R3 or 100mm	R3 or 100mm

5.2.3 TYPE AND LOCATION

Insulation shall have a thermal conductivity not greater than 0.036 W/mK at a mean temperature of 20°C and be one of the following types:

1. Semi rigid mineral wool board with a density of 64-100 kg/m^3.

2. Semi rigid fibreglass blanket with a density 24-32 kg/m^3.

For a distance of 1 metre each side of a fire dampers and in accordance with AS1668.1 install only the semi rigid fibreglass insulation of type 2 above, with a fusing temperature exceeding 1000°C.

Insulation finishes shall be one of the following types:

1. Factory faced perforated aluminium Sisalation 450.

2. 0.5 mm thick zinc anneal sheet; with 2.5mm perforations and 10-15% open area.

For circular ducts use type 2 finishes.

Internal insulation is to be installed in compliance with BCA Section J and the following minimum thickness in the following listed locations:

1. At least 6 metres in the discharge duct of each supply air fan beyond the fan discharge (Min. 50mm thick).

2. At least 6 metres before the fan up to and including the intake plenum of each return and exhaust fan (Min. 50mm thick).

3. At least 3 metres in the discharge duct beyond the fan discharge of each exhaust air fan (Min. 50mm thick).

4. In other locations shown on the drawings.

The duct dimensions shown on drawings for internally lined ducts are inside clear dimensions only. Increase the ducts sizes accordingly.

5.2.4 INSTALLATION METHODS

For insulation with factory faced perforated aluminium Sisalation 450 finish, use pins 2.5mm thick with flat heads 5.0mm diameter designed for stud welding and attached by stud welding the head to the duct at spacing not exceeding 300mm. Pins may be omitted on duct sides less than 225mm wide. Use speed clips at least 25mm diameter made of steel. Overlap all joints with Sisalation 50mm wide glued and protected with 75mm wide Sisalation cover strips.

Use corner angles which are 50mm wide (or 25mm for duct sides less than 300mm) and cover strips which are 50mm wide; and both a minimum of 1mm thick and edge crimped and galvanized.

Provide channels at the ends of duct sections edge crimped and turned back to provide 50mm cover.

For insulation with perforated zinc anneal sheet finish, with transverse joints in metal sheeting, lap sheeting in the direction of air flow, with a minimum of 75mm overlap. Provide shop formed acme-lock longitudinal joints, neatly butted at the corners and cover with 38mm x 38mm angles. Ensure that corner angles and cover strips are edge crimped and fit flush against sheeting without gaps. Where insulation is terminated and at joints, fit end caps or channels with crimped edges to provide a neat finish.

Retain insulation by pin clips, corner angles, cover strips and end channels.

5.3 FLEXIBLE DUCTWORK INSULATION

Flexible ductworks used for air conditioning are to be insulated in compliance with BCA Section J to a minimum of R1 or 40mm.

Should acoustic treatment to flexible ductwork be required, insulated rigid duct shall be provided. The installation of acoustic wavebar on flexible duct is not approved.

5.4 PIPE INSULATION

5.4.1 GENERAL

Insulate all chilled water, refrigerant, hot water, steam and condensate drain pipework, including all valves and fittings within the systems. Insulation thicknesses shall be in compliance with BCA section J.

5.4.2 REFRIGERANT PIPEWORK (FOR SMALL CONDENSING UNITS AND THE LIKE)

Insulate refrigeration suction gas pipework, including valves and fittings with flexible closed cell nitrile rubber insulation, having a minimum wall thickness of 13 mm. Glue the insulation longitudinal and circumferential joints along their full length and glue the ends of the insulation to the pipe using adhesive recommended by the insulation manufacturer to effect a vapour seal.

Finish circumferential joints by wrapping with 50 mm wide pressure sensitive pre-glued PVC tape.

In addition to the above, provide a 0.5mm thick zincanneal sheath finish for all exposed insulated pipework external to the building.

5.4.3 CONDENSATE DRAIN

Insulate condensate drain pipes with flexible closed cell nitrile rubber insulation having a minimum wall thickness of 7 mm. Glue the longitudinal and circumferential joints along their full length and glue the ends of the insulation to the pipe using adhesive recommended by the insulation manufacturer. Taping which compresses the insulation cells are not to be accepted.

5.4.4 INSTALLATION METHODS

Insulation is not to be installed prior to the complete pressure testing of the pipework.

Apply insulation over clean dry surfaces with adhesive applied to all surfaces. Ensure all adhesives are fully compatible for use with the insulation to which they are applied, and are approved for use by the insulation manufacturer.

Joints in insulation shall be butt ended and properly sealed with adhesive and vapour barrier finish as nominated. Preformed sections shall be mitred as necessary to ensure tight fit at bends.

Retain insulation by not less than three 15mm wide aluminium straps per section.

Joints in sheath finish shall have a minimum 40mm overlap. Longitudinal joints shall have a minimum 40mm overlap and be placed at the underside of the pipe.

Retain sheathing using 15mm wide galvanised metal straps at not more than 300mm centres.

Insulate all valves and fittings with cut sections, cemented and tied securely in position with 1.0mm thick nylon mono line or equivalent and vapour sealed. Where valves penetrate insulation ensure the vapour barrier is sealed.

Ensure that the finish of insulation around valves and fittings is of neat appearance, and forms an effective vapour barrier and is arranged to provide moisture drainage.

Install strainer covers to allow easy removal for service with toggle catches to hold covers in position.

Use a sleeved penetration and mineral wool pipe insulation (eg: Bradford ”Fibretex” or equivalent) external to the applied insulation where piping passes through fire rated walls. Extend this insulation a minimum of 300mm beyond walls.

At pipe supports, provide an effective vapour barrier inserted between the circumferential pipe support and the pipe insulation to ensure a continuous vapour barrier for the total length of piping.

Glue sisalation to the wooden block pipe support and to the insulation for a distance of 150mm on either side of the support. Apply a vapour resistant mastic at the end of each section of the insulation and sealed to the pipe on both sides of the wooden block pipe support beneath the sisalation.

5.4.5 INSTALLATION METHODS FOR EXTERNAL PIPEWORK

Pipework installed external to the building shall also comply with the following clause.

Arrange longitudinal joints to have 50mm overlap located at the bottom of the pipe and arranged to shed water. Apply a single continuous 6 mm diameter bead of silicone cement applied within each overlap of each longitudinal joint.

Hold sheathing in place by 12mm wide x 0.5mm thick 316 stainless steel proprietary strapping to the approval of the Builder applied by means of a special purpose tool at 600mm maximum centres.

Provide all 90° bends at least five sections which shall have 50mm overlap silicone cement beads in joints and be held in place with straps.

At pipe hangers, provide an additional reinforcing band of 0.5mm thick 316 stainless steel between hanger strap and sheathing.

SECTION 6 - AUTOMATIC CONTROLS AND BUILDING MANAGEMENT SYSTEMS

6.1 GENERAL

Provide control systems that meet the control strategies of this specification and are designed by a specialist controls supplier.

Equipment offered must have a proven successful application in Australia and the consultant may request the tenderer to demonstrate the capabilities of the equipment in occupied premises.

Full details of the system must be provided for approval.

6.1.1 ALTERNATIVE OFFERS

Alternative offers in any form shall clearly list all deviation from the specified and justify superiority over the specified system for consideration. Tenders with alternative offers from other control specialists shall only be considered if full details of the system offered are included at the time of tender.

6.2 SCOPE OF WORK

The scope of work listed below must be read and implemented in conjunction with all other requirements specified in other Clauses of this worksection “Automatic Controls and Building Management Systems”.

The scope of work must include all labour, tools, delivery of all material, hardware and software and all necessary components required to carry out the supply, installation, testing, commissioning, manufacturing and the defects liability services of the equipment for the complete Building Management and Control System (BMCS):

1. The supply and installation of equipment to control and monitor the operation of new VRV air conditioning system and ventilation fans distributed throughout the buildings.

2. Provide all air conditioning controls/monitoring from the central controller.

3. The supply and installation of equipment to control all other ventilation systems.

4. The supply and installation of new field measuring devices to perform control functions as specified.

5. The supply and installation of all electrical works necessary for the operation of the control systems including, but not limited to, switchboards, control boards, cabling and terminations.

6. Other miscellaneous work including:

    - Painting and identification of all equipment as specified.

    - Commissioning and testing of all systems.

    - Provision of shop drawings.

    - Provision of as-built-drawings, commissioning manuals, operating and maintenance manuals.

    - Provision of training to the operation staff.

    - Warranty against defects for 12 months.

6.3 AUTOMATIC CONTROLS

6.3.1 GENERAL

6.3.1.1 Responsibilities

General

Provide automatic control systems to perform the documented control functions.

Supply and commission control systems that are safe and stable in operation under all anticipated operating conditions including start up, shut down and fault condition.

Provide fully automatic restoration of control system operation after any service interruption of any duration except for documented manual restoration of operation,

Provide control devices and software to protect personnel from injury and equipment from damage by either normal or abnormal operation of the control system, including the removal and reapplication of power whether expected or unexpected.

If the documented control systems interface or connect to existing control systems, provide new control components and software that are either identical to the existing or, if not identical, compatible. If not identical, provide evidence that the proposed components are compatible.

Provide components that function correctly in their local environment.

6.3.2 PRODUCTS

6.3.2.1 General

Control components

Control components should be suitable for the application and location in which they are installed. For example, room temperature sensors should not be used for sensing temperature in ducts or outdoors.

Provide sensors and control components that are:

1. Of corrosion resistant construction.
2. Suitable for the respective operating environment.
3. Not affected by the accumulation of dust or moisture, extraneous influences or variation of ± 30% in supply voltage.
4. Protected against the entry of vermin.
5. Selected for a response time appropriate to the application.
6. Provided with proprietary connections suitable for the size and type of cable used.

6.3.2.2 Input devices – General

Provide input devices with the following characteristics:

1. With range, accuracy and response time appropriate to the required control function including the effects of transducer accuracy and signal transmission errors.
2. Maintain documented performance over time.

3. Requiring maintenance or re-calibration to maintain performance at not more often than 12 month intervals.

4. Designed for the type of location and application in which they are installed.

5. Located for easy access for inspection, calibration, cleaning and maintenance.

6. Tamperproof if located in occupied areas.

7. Protected by location or otherwise from extraneous influences including sunlight, heat sources and non-representative locations.

8. Not affected by induced voltages or EMI**.**

Transducers

If required for signal conversion, provide signal transducers to convert sensed signal to the required system signal standard. Provide transducers with integral, accessible zero and span adjustments, open and short circuit protection and reverse polarity protection.

6.3.2.3 Input devices – TEMPERATURE

Approval and testing of thermostats and temperature controls shall be to AS/NZS 3161.

Temperature sensors – room

Provide tamperproof sensors in an ABS or polycarbonate case ventilated to the room air and thermally insulated from the wall.

Sensing element shall be a resistance temperature device (RTD) or thermistor.

Thermistors are temperature sensitive semiconductor devices in which resistance falls with increasing temperature.

Accuracy shall be within ± 0.3°C over the temperature range required for the project application.

Repeatability shall be ± 0.1°C.

6.3.2.4 Input devices – flow and velocity

Flow switch – air

General: Conform to the clause Differential pressure switch – duct elsewhere in this worksection.

6.3.2.5 Gas sensors

Refrigerant sensor

Type: Refrigerant specific with low cross sensitivity to other refrigerants and gases. Provide display of refrigerant concentration in parts per million and means to automatically re-zero. Provide 3 alarm levels, each with a front panel light and a latching binary contact closure for the control of remote devices.

Range: Measure and display at least 0 to 999 parts per million with resolution of 1 part per million.

Ambient temperature operating range: At least 10°C to 50°C.

Activation alarm: At less than the practical limit for the respective refrigerant in AS/NZS 5149.1.

Sensitivity: Better than ±10% of the practical limit for the respective refrigerant in AS/NZS 5149.1.

Regular maintenance requirements: Limited to recalibration once per year and monthly confirmation of clean air source for recalibration.

Output:

1. Continuous: Analogue corresponding to local display value.

2. Alarm: Latching binary contact closed if level exceeds set point.

6.3.3 INSTALLATION

Mark each control component.

6.3.3.1 Installation – input devices

Sensors in occupied areas

Installation: Securely attach to walls, ceilings or columns. Mount on concealed junction boxes and seal cable entries to prevent air from the cavity entering the junction box. Conceal all wiring from view inside wall, column or ceiling space.

Wall or column mounted sensors: Locate 1500 mm above floor level.

Sensors in unoccupied areas

Installation: Conform to **Devices in occupied areas** except that devices may be mounted on surface mounted junction boxes with wiring in exposed conduit.

Sensors – outdoor air

Installation: Either locate in the outdoor air stream of an air handling unit that operates at all times outside air temperature is required or locate in an accessible external location on a south facing wall and protected from rain and sun.

Refrigerant sensor

General: Conform to AS/NZS 5149.3 clause 8.8.

Location: Locate sensors to accurately sense concentrations. Conform to manufacturer's recommendations.

Venting: Provide a 50 mm copper vent line from the safety valve assembly to atmosphere. Install a T-piece at the safety valve flange to provide a dirt leg and sampling valve. Provide a flexible piping connection at the safety valve and support pipework so no load is exerted on the valve assembly. Provide a stainless steel mesh screen to prevent foreign matter entering the vent.

6.3.3.2 Installation – controllers

Install controllers within dedicated switchboard enclosures.

Provide plasticised fade-free points lists in enclosure door pocket. Include in the list terminal numbers, point addresses and short and long descriptions.

6.3.3.3 Testing and commissioning

Conform to Mechanical commissioning.

6.4 VRV CENTRAL CONTROL SYSTEM

6.4.1 RESPONSIBILITIES

Performance

Provide control, monitoring and management of the building services through a networked VRV Central Contoller including but not limited to the following:

1. Connection and interface of distributed controllers and other equipment.
2. UDP/IP protocol in accordance with BACnet for communication with the web server and for communication between control modules.
3. Schedules, alarms, trends, reports, logs and priorities.
4. Monitoring, control and management of the BACnet points and objects.
5. Software and software development to perform the functions.
6. All hardware necessary hardware.

System performance

Conform to the following minimum criteria over network connections:

1. Graphic display: Display current data on a graphic containing 20 dynamic points within 10 seconds.
2. Graphic refresh: Update with current data a graphic containing 20 dynamic points within 8 seconds and automatically refresh every 15 seconds.
3. Configuration and tuning screens: Automatically refresh within 6 seconds screens used for configuring, calibrating or tuning points, proportional-integral-derivative (PID) loops and similar control logic.
4. Object reaction to command:
   - Binary object: react within 2 seconds.
   - Analog object: Begin reacting to command within 2 seconds.
5. Alarm response time at the server: Annunciate an object that goes into alarm within 15 seconds.
6. Program execution frequency: Arrange so that custom and standard applications are capable of running once every 5 seconds. Select execution times consistent with the process under control.
7. Reporting accuracy: Report values with minimum documented end-to-end accuracy.

Expansion provisions

Network architecture: Provide facilities so the system can be expandable to at least twice the documented input and output objects.

6.4.2 STANDARDS

General

Building automation system protocol: BACnet® to ANSI/ASHRAE 135, including Annex J. (Referred to in this worksection as BACnet.)

LAN technology: To ISO/IEC 8802-3.

6.4.3 SUBMISSIONS

Documentation

Submit documentation including:

1. An outline functional specification containing a list of standard software modules used in the system and a brief summary of function and location.

2. Schedule of all input and output points cross-referenced to the functional specification.

3. For each software module:

   - A detailed functional description. Provide flow charts if necessary.

   - The sequence of operation.

   - Decision points.

   - Calculations performed.

   - Action in the event of a fault condition.

   - Instructions for manual control.

   - Start-up sequence and shutdown sequence under normal conditions.

   - Start-up sequence and shutdown sequence under fault and power failure.

   - A schedule of inputs and outputs for the module including details of the source.

4. Conventions:

   - Proposed naming conventions for BACnet objects.

   - Proposed description properties for BACnet objects and their formats.

   - Proposed non-standard BACnet assignments

   - Proposed assignment of priority levels not assigned in BACnet.

   - Proposed conventions for network numbering.

   - Proposed device object identification convention.

   - Proposed convention for the use of text for multistate objects.

Drawings

Submit drawings including:

1. Schematic diagrams of control, communication and power wiring.
2. Interface wiring to control system.
3. Network riser diagrams of wiring between server and control panels.

Inspection and Test Plans (ITPs)

Provide ITPs for each system and function showing:

1. Function to be tested.
2. Test method (including hardware required) for on site verification of system prior to changeover.
3. List of inputs and outputs.
4. Acceptance criteria.
5. Name and signature of person verifying test.

Manuals

Submit manuals including:

1. Draft operators manual.
2. Draft training manual.

Prototypes

Submit prototypes of the following:

1. Graphical symbols.
2. Graphical displays.
3. Reports.
4. Trend graphs.

Product data

Submit product data for each hardware component including:

1. Web server.
2. Monitors.
3. Keyboards.
4. Power supplies.
5. Battery backups.
6. Interface equipment between server and control panels.

7. Operating System software.
8. Operator interface software.
9. Colour graphic software.
10. Third-party software.

Technical data

Submit technical data including BACnet Protocol Implementation Conformance Statement (PICS) for each component.

Qualifications

Installers: Submit evidence of successful completion by installers and operators employed on the installation of control system manufacturer's training for installers and operators. Provide course outlines.

6.4.4 EXECUTION

6.4.4.1 Programming

Operator interface

Standard Graphics: Provide dynamically updating point information on graphics as documented. Show on each equipment graphic related input and output points and relevant calculated points.

Interface software: Provide operator interface software and functions including but not limited to: operating system software, operator interface database and third-party software installation and integration required for successful operator interface operation.

6.4.4.2 Software development

Test facilities

Requirement: Provide each software module or logical set of modules with a Test Mode (set by internal flag), software Test Module or similar means which permits simulation of all inputs both digital and analogue and visual representation of module outputs.

Inspection and test plans

Requirement: Provide for each software function in the control system produce, as part of the software development phase, an Inspection and Test Plan for testing the correct operation of the function.

Test criteria: Identify, in the detailed Inspection and Test Plans, the criteria declaring the performance of software module or group of modules. Design the detailed test cases to test every alternative path through a module and to exercise all boundary conditions for values i.e. maximum and minimum cases and all extreme conditions that could ever be presented to the module.

6.4.4.3 Software ownership and access

Ownership

Requirement: At the date of practical completion transfer ownership of all software and supporting documentation produced under this contract to the principal.

Licences:

1. Operator interface and related software: Unlimited licences.

2. Other software: A minimum of three (3) concurrent licences.

6.4.4.4 Pre-completion tests

Software testing

Test all software using inbuilt test modules and connected to test panel. Test against the documented functions to simulate all normal and fault conditions.

System testing

Test every point, function and system. Provide all hardware and software required for the testing process.

Submit results of testing on Inspection and Test Plans and certify correct operation of all aspects of the Functional Specification.

System performance

Test system performance using manufacturer's recommended hardware and software for web server and web browser.

6.4.4.5 Completion

Training

General Provide training to enable operators to accomplish the following objectives:

1. Proficiently operate the system.

2. Understand automatic control system architecture and configuration.

3. Understand automatic control system components.

4. Understand system operation, including automatic control system, control and optimising routines (algorithms).

5. Operate workstation and peripherals.

6. Log on and off system.

7. Access graphics, point reports and logs.

8. Adjust and change system set points, time schedules and holiday schedules.

9. Recognise common HVAC system malfunctions by observing system graphics, trend graphs and other system tools.

10. Understand system drawings and Operation and Maintenance manual.

11. Understand job layout and location of control components.

12. Access data from automatic control system controllers.

13. Create and change system graphics.

14. Create, delete and modify alarms, including configuring alarm reactions.

15. Create, delete and modify point trend logs (graphs) and multi-point trend graphs.

16. Configure and run reports.

17. Add, remove and modify system's physical points.

18. Add operator interface stations.

19. Add a new controller to system.

20. Maintain software and prepare backups.

21. Interface with job-specific, third-party operator software.

22. Add new users and understand password security procedures.

Divide presentation of objectives into three sessions. Participants will attend one or more of sessions, depending on knowledge level required as follows:

1. Day-to-day operators.

2. Advanced operators.

3. System managers and administrators.

Materials: Provide course outline and training materials. Provide one copy of training material per student.

Hardware: Perform classroom training using a network of working controllers, representative of installed hardware.

Repeat training

Operator training: In addition to the above, provide on-site operator training during the defects liability period.

Number and duration of training sessions: Provide training sessions of at least 4 hours at 3 month intervals (a total of 4 sessions).

6.5 CONTROL STRATEGIES

The following outlines the control strategies that are required at each FPU/FTU on a standalone basis:

6.3.1 VRV AIR CONDITIONING

The ceiling mounted cassettes and ducted fan coil units are each individually controlled and shall be controlled by proprietary electronic sensors and wall mounted controllers. Controllers to come complete with a proprietary programmable time clock. Outside of programmed hours, each air conditioning controller shall activate the associated unit. Office areas shall be provided with after-hours activation via the on/off switch, enabling the associated unit for a period of 2-hours.

A low, medium and high fan speed for the indoor units shall be provided as part of the main controller. A wall mounted controller shall be provided for each air conditioning unit, which shall control the heating and cooling cycles.

Once started, each unit shall operate cooling and heating as required to maintain space conditions.

Each controller shall incorporate the following only:

- ON/OFF switch.
- Restricted temperature set point between 18 to 24°C.
- FAN High-medium-low selector switch.

A central controller shall be provided to monitor and control all air conditioning units and be located within the Administration room. Central controller to be programmed to limit user control as noted above and provide relevant time scheduling.

Provide remote access to allow building staff to access and control the building's air conditioning units via the internet.

The central controller shall include but not limited to, all necessary graphics; collective starting/stopping of indoor units, temperature settings, zoning/group scheduling, operation history, stop input from central monitoring panel and power distribution of air conditioning units.

The central controller shall also control and monitor all ventilation fans.

6.3.2 COMMS ROOM AIR CONDITIONING

The Comms Room wall mounted AC unit shall be cooling only and shall be controlled by proprietary electronic sensors and wall remote controller located inside the Comms room.

A low, medium and high fan speed for the indoor units shall be provided as part of the main controller.

A "DAIKIN" wall mounted combined temperature sensor and controller shall be provided inside the Comms room, which shall control the cooling cycle.

Once started, the unit shall operate in cooling mode to maintain space conditions.

The wall mounted unit shall be equipped with a condensate drain pump kit for appropriate drainage.

Each controller shall incorporate of the following as a minimum:

- ON/OFF switch.
- Temperature set point.
- FAN High-medium-low selector switch.

6.3.3 OUTSIDE AIR

Outside air fans, serving in-ceiling fan coil units and cassettes shall be interlocked with associated fan coil units.

6.3.4 TOILET EXHAUST

Centralised toilet exhaust fans shall be provided with a 7 day programmable time clock (adjustable) initially set to operate 24 hours.

6.3.5 ACC WC & CLEANERS STORE EXHAUST FAN

Exhaust fan shall be provided with a 7 day programmable time clock (adjustable) initially set to operate 24 hours.

6.5.1 TIME SWITCH

Provide time switches as required in compliance with BCA Section J requirements.

6.5.2 VENTILATION FANS

Switch the ventilation fans ON/OFF according to the time schedule. Install an alarm if fan fails to start.

6.5.3 FIRE MODE OPERATION

On receipt of the Fire Alarm Signal the equipments shall initiate the following, in accordance with the Australian Standard AS1668 – Part 1 as follows:

- MSSB-1 to shut down all mechanical equipment.
- Provide auto-reset for all mechanical equipment upon resetting of fire alarm.

SECTION 7 - MECHANICAL ELECTRICAL SYSTEMS

7.1 GENERAL

This mechanical electrical systems section of the specification deals, in general, with the quality and types of materials and accessories, and the methods of working and standards of workmanship to be employed in the implementation of the electrical work included in the *"Scope of Work"* section of this Specification.

7.1.1 OBVIOUS WORK

The installation of all electrical systems shall be complete in all aspects and shall include all materials, components and work which is obviously necessary for the satisfactory and proper functioning of the installation even though such materials, equipment or work may not be explicitly detailed in the Specification or shown on the drawings.

7.1.2 COMPLIANCE WITH AUTHORITIES AND STANDARDS

The complete installation shall be in compliance with Wiring Rules AS/NZS3000 including all ensuing amendments, with the requirements of the Local Supply Authority Service Rules and with all other applicable regulations and by-laws of Statutory Authorities.

Work not covered by the requirements of Statutory Authorities shall be in compliance with the appropriate and latest publication from the Standards Australia or if specification is not yet issued by Standards Australia, comply with the British Standards Institution relevant publication.

7.1.3 EQUIPMENT AND UNIFORMITY OF EQUIPMENT

All electrical equipment and fittings shall be new, of first grade design and manufacture and shall be completely satisfactory in respect of operation, control, safety and maintenance under all conditions of service.

Uniformity of type and manufacture of each item of equipment plus accessories shall be preserved throughout the whole of the installation.

7.1.4 CONTINUITY OF SUPPLY

Where electrical facilities exist on the site and/or premises, these facilities shall be maintained to suit the convenience of consumers; any interruption to the electricity supply being made only with the written consent of the client's representative.

7.2 LOW VOLTAGE POWER

7.2.1 GENERAL

System description

Supply: Conform to the following:

Nominal supply voltage	230/400 V
Number of phases	3
Frequency	50 Hz

Number of wires – system	4
Neutral connection	MEN

Standards

General: To AS/NZS 3000 Section 2 unless otherwise documented.

Electrical systems: To AS/NZS 3008.1.1 and SAA HB 301.

Degrees of protection (IP code): To AS 60529.

EMC: To AS/NZS 61000.

Telecommunications systems: To AS/ACIF S008, AS/ACIF S009, AS/NZS 3080, SAA HB 243 and SAA HB 29.

Interpretations

Definitions: For the purposes of this worksection the definitions given below apply.

1. Extra-low voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.
2. Low-voltage: Exceeding extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.

Submissions

Samples: Submit samples of all visible accessories and equipment.

Technical data: Submit the following information for each main, submain and final subcircuit for which calculation is the responsibility of the contractor.

1. Single line diagram.
2. Fault Levels at switchboards.
3. Maximum demand calculations.
4. Cable and conductor cross sectional area and insulation type.
5. Cable operating temperature at design load conditions.
6. Voltage drop calculations at design load conditions.
7. Touch potential calculations.
8. Protective device characteristics, e.g. curves, I^2t.
9. Discrimination and grading of protective devices.
10. Prospective short circuit current automatic disconnection times.
11. Final subcircuits may be treated as typical for common route lengths, loads and cable sizes.

12. Touch potential automatic disconnection times.

13. Earth fault loop impedance for testing and verification.

14. Certify compliance with AS/NZS 3000, for electrical services.

7.2.2 PRODUCTS

Wiring systems

Selection: Provide wiring systems appropriate to the installation conditions and the function of the load.

Earthing systems: Provide an earthing system complying with AS/NZS 3000 Section 5.

Power cables

Standard: Polymeric cables: To AS/NZS 5000.1.

Cable: Use multi-stranded copper cable generally.

Default insulation: V-75.

Default sheathing: 4V-75.

Minimum size: Power sub-circuits: 2.5 mm^2 and Sub-mains: 6 mm^2.

Voltage drop: Install final subcircuit cables within the voltage drop parameters dictated by the route length and load.

Fault loop impedance: Provide final subcircuit cables selected to satisfy the requirements for automatic disconnection under short circuit and earth fault/touch voltage conditions.

Distribution cables: To AS/NZS 4961.

Conductor colours: For fixed wiring, provide coloured conductor insulation. If this is not practicable, slide at least 150 mm of close fitting coloured sleeving on to each conductor at the termination points.

Active conductors in single phase circuits: Red.

Active conductors in polyphase circuits:

- A phase: Red.
- B phase: White.
- C phase: Blue.

Accessories

General: Provide accessories as documented.

Conformity: All accessories and outlets located in close proximity are to be the same manufacture, size and material if available.

Emergency stop switches shall be to IEC 60947.5 Standard.

7.2.3 INSTALLATION

Power cables

Standard: Classifications to AS/NZS 3013.

Handling cables: Report damage to cable insulation, serving or sheathing.

Stress: Ensure that installation methods do not exceed the cable's pulling tension. Use cable rollers for cable installed on tray/ladders or in underground enclosures.

Straight-through joints: Unless unavoidable due to length or difficult installation conditions, run cables without intermediate straight-through joints.

Cable joints: Locate in accessible positions in junction boxes.

Extra-low voltage circuits: Individual wiring of extra-low voltage circuits: Tie together at regular intervals.

Tagging: Identify multicore cables and trefoil groups at each end with stamped non-ferrous tags clipped around each cable or trefoil group.

Marking: Identify the origin of all wiring by means of legible indelible marking.

Cable systems: Provide the following:

1. Accessible concealed spaces: Thermoplastic insulated and sheathed cables.
2. Inaccessible concealed spaces: Cable in UPVC conduit.
3. Plant rooms: Cable in heavy duty UPVC conduit, or on tray or in duct.
4. Plastered or rendered surfaces: Cable in UPVC conduit.
5. Stud walls without bulk insulation: Thermoplastic insulated and sheathed cables.
6. Walls filled with bulk thermal insulation: Cables in PVC conduit.

Fire-rated cables

Protection: If exposed to mechanical damage, provide protection to AS/NZS 3013.

Copper conductor terminations

General: Other than for small accessory and luminaire terminals, terminate copper conductors to equipment, with compression-type lugs of the correct size for the conductor. Compress using the correct tool or solder.

Within assemblies and equipment: Loom and tie together conductors from within the same cable or conduit from the terminal block to the point of cable sheath or conduit termination. Neatly bend each conductor to enter directly into the terminal tunnel or terminal stud section, allowing sufficient slack for easy disconnection and reconnection.

Alternative: Run cables in UPVC cable duct with fitted cover.

Identification: Provide durable numbered ferrules fitted to each core, and permanently marked with numbers, letters or both to suit the connection diagrams.

Spare cores: Identify spare cores and terminate into spare terminals, if available. Otherwise, neatly insulate and neatly bind the spare cores to the terminated cores.

Completion tests

Site tests:

1. Inspection: Visually inspect the installation to before testing. Record on a checklist.

2. Test and verify the installation to AS/NZS 3000 Section 8, using the methods outlined in AS/NZS 3017 Record the results of all tests.

Spare parts

Spare parts: As documented.

7.3 CABLE SUPPORT AND DUCT SYSTEMS

7.3.1 GENERAL

Standards

Cable trunking systems: To AS/NZS 4296 and to the Wiring enclosures and cable support systems schedule.

Conduits and fittings for electrical installations: To AS/NZS 2053.1, AS/NZS 2053.2, AS/NZS 2053.3, AS/NZS 2053.4, AS/NZS 2053.5, AS/NZS 2053.6, AS/NZS 2053.7 and AS/NZS 2053.8.

Submissions

Shop drawings: Submit shop drawings showing the following:

1. Cable tray and trunking routes.

2. Layout of cable supports and enclosures on the current architectural background coordinated with the structure and other services.

Technical data: Submit technical data for the following:

1. Ducted wiring enclosure systems.

2. Cable support systems.

7.3.2 PRODUCTS

Conduits

Standards:
To AS/NZS 2053.1,AS/NZS 2053.2, AS/NZS 2053.3, AS/NZS 2053.4, AS/NZS 2053.5, AS/NZS 2053.6, AS/NZS 2053.7 and AS/NZS 2053.8.

Sizes: Conduits size shall be ≥ 20 mm and Underground conduits shall be ≥ 25 mm.

Galvanized water pipe: Medium or heavy to AS 1074.

Fixing saddles: Double sided fixed.

Metallic conduits and fittings

Standards: To AS/NZS 2053.7 or AS/NZS 2053.8.

Type: Screwed steel.

Fixing saddles:

1. Internal: Zinc plated.

2. External: Hot dipped galvanized.

Corrosion protection for steel conduits: Paint ends and joint threads with zinc rich organic primer to AS/NZS 3750.9.

Non-metallic conduits and fittings

Non-metallic conduits and fittings shall be in compliance with AS/NZS 2053.2, AS/NZS 2053.3, AS/NZS 2053.4, AS/NZS 2053.5, and AS/NZS 2053.6.

Solar radiation protection: Required for exposed conduits and fittings.

Flexible conduit: Provide flexible conduit to connect with equipment and plant subjected to vibration. If necessary, provide for adjustment or ease of maintenance. Provide the minimum possible length.

Associated fittings:

1. Type: The same type and material as the conduit.

2. Wall boxes on UPVC conduits: For special size wall boxes not available in UPVC, provide prefabricated earthed metal boxes.

Inspection fittings: Provide inspection-type fittings only in accessible locations and where exposed to view.

Joints: Cemented or snap-on joints.

Ducted wiring enclosures

Standards: Cable duct/trunking systems: To AS/NZS 4296.

Cable duct

Material: Metal.

Construction: Solid.

Covers shall be in accessible locations as follows: Screw-fixed or clip-on type removable only with the use of tools.

Accessories: Purpose-made to match the duct system.

Cable support: Except for horizontal runs where the covers are on top, support wiring with retaining clips at intervals of not more than 1000 mm.

Cable tray/ladder support systems

System: Provide a complete cable support system consisting of trays or ladders and including brackets, fixings.

Selection: Run cables < 13 mm diameter on cable trays or in ducts.-

Standard: NEMA VE-1.

Type tests: To NEMA VE-1.

Manufacture: Provide proprietary trays, ladders, fittings and accessories from a single manufacturer for the same support system.

Selection: Select cable tray/ladder in conjunction with support system installation to achieve the documented loading and deflection requirements.

Spare capacity: ≥ 50%.

7.3.3 INSTALLATION

Unsheathed cables – installation

Provide permanently fixed enclosure systems, assembled before installing wiring. Provide draw wires to pull in conductor groups from outlet to outlet, or provide ducts with removable covers.

Conduit systems - installation

Set out: If exposed to view, install conduits in parallel runs with right angle changes of direction.

Conduits in roof spaces: Locate below roof insulation and sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits.

Inspection fittings: Locate in accessible positions.

Draw cords: Provide 5 mm^2 polypropylene draw cords in conduits not in use.

Draw-in boxes: Provide draw-in boxes as follows:

1. In straight runs at > 30 m: Spacing ≤ 30 m.

2. At changes of level or direction.

Underground draw-in boxes: Provide casketed covers and seal against moisture.

Expansion: Allow for thermal expansion/contraction of conduits and fittings due to changes in ambient temperature conditions. Provide expansion couplings as required.

Rigid conduits: Provide straight long runs, smooth and free from rags, burrs and sharp edges. Set conduits to minimise the number of fittings.

Routes: Run conduits concealed in wall chases, embedded in floor slabs or installed in inaccessible locations directly between points of termination, minimising the number of sets. Do not provide inspection fittings.

Conduits in concrete slabs:

1. Route: Do not run in concrete toppings. Do not run within pretensioning cable zones. Cross pretensioning cable zones at right angles. Route to avoid crossovers and minimise the number of conduits in any location. Space parallel conduits ≥ 50 mm apart.

2. Minimum cover: The greater of the conduit diameter and 20 mm.

3. Fixing: Fix directly to top of the bottom layer of reinforcing.

Hollow-block floors: Locate conduits in the core-filled sections of precast hollow-block type floors.

Columns: Conduits in columns be as follows:

1. ≤ 4 per column.

2. ≤ 25 mm diameter.

3. Locate conduits centrally in each column.

Bends: Enter columns via ≥ 150 mm radius sweep bends. Do not use elbows.

Chasing: Do not chase columns.

Cable tray/ladder support systems – installation

Cable trays: Galvanized steel.

Fixing to building structure: Fix supports to the building structure or fabric by means of direct fixing hangers or brackets.

Cable fixing: Provide strapping or saddles suitable for fixing cable ties.

MIMS cables: Provide non-magnetic straps.

Bend radius: Provide bends with an inside radius ≥ 12 times the outside diameter of the largest diameter cable carried.

Cable protection: Provide rounded support surfaces under cables where they leave trays or ladders.

Access: Locate trays and ladders to provide ≥ 150 mm free space above and ≥ 600 mm free space on at least one side.

Clearances:

1. From hot water pipes: > 200 mm.

2. From boilers or furnaces: > 500 mm.

3. EMI: Locate support systems for electrical power cabling and communication cabling to minimise electromagnetic interference.

7.4 SWITCHBOARDS

7.4.1 GENERAL

Responsibilities

Provide custom-built switchboards as follows and as documented.

Standard: To AS/NZS 3439.1.

Interpretations

Definitions: For the purposes of this worksection the definitions given below apply.

1. Custom-built assemblies: Low voltage switchgear and controlgear assemblies manufactured to order and incorporating proprietary components and proprietary bus-bar assemblies.

2. Rated currents: Rated currents are continuous uninterrupted current ratings within the assembly environment under in-service operating conditions.

3. Rated short-circuit currents: Maximum prospective symmetrical root mean square (r.m.s.) current values at rated operational voltage, at each assembly incoming supply terminal, excluding effects of current limiting devices.

Submissions

Product data: Submit the following:

1. Makes, types and model numbers of items of equipment.

2. Type test certificates for components, functional units and assemblies including internal arcing-fault tests and factory test data.

3. Design calculations of non-type tested and non- proprietary busbar assemblies.

4. Overall dimensions.

5. Fault level.

6. IP rating.

7. Rated current of components.

8. Number of poles and spare capacity.

9. Mounting details.

10. Door swings.

11. Paint colours and finishes.

12. Access details.

13. Schedule of labels.

7.4.2 PRODUCTS

Custom-built switchboard construction

General: Custom built switchboards as documented.

IP rating:

1. General: IP 42.

2. Weatherproof: IP 56 minimum.

Separation: Form 1.

Spare pole capacity: ≥ 20%.

Layout: Specify cabinet arrangement and safety measures e.g. safety measure number and accessibility. Refer to AS/NZS 3439.1 clause 7.7 for guidance on safety measures by constructional means or installation, and requirements relating to accessibility in service. Position equipment to provide safe and easy access for operation and maintenance. Group devices according to function.

Compartments: Separate shipping sections, subsections, cable and busbar zones, functional unit modules and low voltage equipment compartments by means of vertical and horizontal steel partitions which suit the layout and form of separation.

Form 1 enclosures: Separate into compartments by means of partitions at 1.8 m maximum centres.

Segregation: Segregate BCA emergency equipment from non-emergency equipment by means of metal partitions designed to prevent the spread of a fault from non-emergency equipment to emergency equipment.

Enclosure materials: Fabricate from sheet metal of rigid folded and welded construction.

Material: e.g. rolled (or cold formed) steel sections, extruded aluminium sections for supporting and mounting structures; non-insulating type for mounting panels; 1.6 mm sheet steel, 1.6 mm stainless steel, 3 mm aluminium sheet, for enclosures and escutcheon plates; 6 mm thick steel (or stainless steel) rolled (or cold-formed) channels, or extruded aluminium section for plinths.

Material: ≥ 1.6 mm thick metallic-coated sheet steel.

Coating class:

1. Indoor assemblies: Z200.

2. Outdoor assemblies: Z450.

Ventilation: Provide ventilation to maintain design operating temperatures at full load.

Insect proofing: Cover ventilation openings with non-combustible and corrosion resistant 1 mm mesh.

Equipment mounting panels: To support the weight of mounted equipment.

Equipment fixing: Bolts, set screws fitted into tapped holes in metal mounting panels, studs or proprietary attachment clips. Provide accessible equipment fixings which allow equipment changes after assembly commissioning. For lightweight equipment, provide combination rails and proprietary clips.

Lifting provisions: For assemblies with shipping dimensions exceeding 1800 mm high x 600 mm wide, provide fixings in the supporting structure and removable attachments for lifting.

Supporting structure:

1. Wall mounted: ≤ 2 m^2.

2. Floor mounted: > 2 m^2.

Supporting structure: Provide concealed fixings or brackets to allow assemblies to be mounted and fixed in position without removing equipment.

Floor-mounting: Provide mild steel channel plinth, galvanized to class Z600, with toe-out profile, nominal 75 mm high x 40 mm wide x 6 mm thick, for mounting complete assemblies

on site. Drill M12 clearance holes in assembly and channel and bolt assemblies to channel. Prime drilled holes with zinc rich organic primer to AS/NZS 3750.9.

Cable entries: Provide cable entry facilities within assembly cable zones for incoming and outgoing power and control cabling. Provide sufficient clear space within each enclosure next to cable entries to allow incoming and outgoing cables and wiring to be neatly run and terminated, without undue bunching and sharp bends.

Cover plates: Provide 150 mm maximum width cover plates butted together and covering the continuous cable entry slot.

Gland plates: Provide removable gland plates fitted with gaskets to maintain the degree of protection.

Gland plate materials: 1.5 mm thick steel, 5 mm thick composite material or laminated phenolic.

Covers maximum dimensions: 900 mm wide and 1.2 m^2 surface area.

Covers fixing: Fix to frames with at least 4 fixings. Provide corrosion-resistant acorn nuts if the cover exceeds 600 mm in width. Rest cover edges on the cubicle body or on mullions. Do not provide interlocked covers.

Handles: Provide corrosion resistant D type handles.

Escutcheons: For doors enclosing circuit breakers, provide escutcheon plates as barriers between operating mechanisms and live parts.

Escutcheon plates: Provide plates or removable covers with neat circuit breaker toggle cut-outs allowing interchangeability of 1, 2 and 3 pole circuit breakers. Provide corrosion-resistant lifting handles or knobs. Provide unused circuit breaker toggle cut-outs with blanking in-fill pole covers.

Escutcheon plate maximum dimensions: 900 mm wide and 1.2 m^2 surface area.

Factory finishes

Standard: To AS 2700.

Extent: Apply protective coatings to internal and external metal surfaces of assembly cabinets including covers, except to stainless steel, galvanized, electroplated, or anodised surfaces and to ventilation mesh covers.

Finish coats: Thermoset powder coating to AS 4506 or two-pack liquid coating of AS/NZS 3750.13 primer and proprietary or epoxy acrylic full gloss spray finish to **Factory finishes schedule**.

Factory finishes schedule

Mounting structure (brackets)	To match enclosure
Enclosure	Indoor assemblies: Orange X15 Outdoor assemblies: Avocado green G34 Assembly interior: White

Escutcheons	Removable equipment panels: Off white Y35
Doors	To match enclosure
Plinths	Black

Busbars

General: Provide proprietary busbar systems within assemblies, extending from incoming supply terminals to the line side of protective equipment for outgoing functional units and for future functional units.

Type: Multiple proprietary insulated busbar assemblies, verified for short circuit capacity and temperature – rise limits by type tests.

Standards: To AS 3768, AS 3865 and AS 60890.

Neutral links and earth bars

Terminals: Provide terminals for future circuits.

Links: Assembly capacity > 36 poles: Provide neutral links and earth bars at the top and bottom of the circuit breaker section.

Links: Assembly capacity ≤ 36 poles: Provide links and bars at the point of entry of incoming supply cables.

Mounting: Mount neutral links on an insulated base.

Control circuits: Provide separate neutral links and earth bars.

Labels: Provide labels for neutral and earth terminals.

Cables > 10 mm^2: Provide bolts or studs.

Internal wiring

Wiring: Cable type: 0.6/1 kV copper cables. Provide V-90HT insulation where directly connected to active and neutral busbars.

Cable interconnections: For the main circuit supply, provide cable interconnections as follows:

1. ≥ 1.5 mm^2 internal cables, with minimum V75 insulation rating with stranded copper conductors rated to AS/NZS 3008.1.1. Provide cables with current ratings suitable for the internal assembly ambient air temperature and for temperature rise limits of equipment within the assembly.

2. Run cables clear of busbars and metal edges.

3. Run cables neatly. Provide slotted trunking sized for future cables or tie at 150 mm maximum intervals with ties strong enough to withstand magnetic stresses created at the specified fault current. Do not provide adhesive supports.

4. Ensure wiring for future equipment can be installed without removal of existing equipment.

5. Terminate control cables and motor control circuits in tunnel terminals or, if necessary, provide suitable palm type lugs and correct crimp tool.

6. If recommended by device manufacturers, provide shielded wiring.

Adjacent circuit breakers: If suitable proprietary multi-pole busbar assemblies are available to link adjacent circuit breakers, do not provide cable interconnections.

Cables > 6 mm^2: Terminations:

- Tunnel terminals: Single cables.
- Other connection points or terminals: ≤ 2 cables.

Cables > 6 mm^2: Supports:

- Spacing at enclosure: ≤ 200 mm from a termination.
- Spacing generally: ≤ 400 mm.
- Strength: Capable of withstanding forces exerted during fault conditions.

Control and indication circuits: Minimum size: 1 mm^2 with 32/0.2 stranding.

Control and indication circuits: Cable colours: Colour code wiring as follows:

- A phase: Red.
- B phase: White.
- C phase: Blue.
- Neutral: Black.
- Earthing: Green-yellow.

7.4.3 EXECUTION

Assembly installation

Fixing: Before making inter-panel connections, fix assemblies and metering equipment enclosures into position, level and plumb.

Assembly entries

Cable entries: Neatly adapt one or more cable entry plates, if fitted, to accept incoming cable enclosure. Provide the minimum number of entry plates to leave spare capacity for future cable entries. Do not run cables into the top of weatherproof assemblies.

Single core cables rated > 300 A: Pass separately through non-ferrous gland plates. Do not use metal saddles.

Cable enclosures: Continue cable enclosures to or into assemblies and fit cable entry plates so that the IP rating of the assembly and the fire rating of the cable are maintained.

Cable supports: Support or tie cables within 200 mm of terminations. Provide cable supports suitable for stresses resulting from short circuit conditions.

7.5 SWITCHBOARD COMPONENTS

7.5.1 PRODUCTS

General

Rated duty: Uninterrupted in non-ventilated enclosure.

Rated making capacity (peak): ≥ 2.1 x fault level (RMS) at assembly incoming terminals.

Utilisation category: To AS 60947.1clause 4.4.

Circuits consisting of motors or other highly inductive loads: At least AC-23.

Other circuits: At least AC-22.

Coordination: Select and adjust protective devices to discriminate under over-current and earth faults.

Enclosure: IP4X minimum.

Switch-isolator

Standard: To AS 60947.1 and AS/NZS 3947.3.

Poles: 3.

Operation: Independent manual operation including positive ON/OFF indicator.

Shrouding: Effective over range of switch positions.

Rated breaking capacity: ≥ rated full load current.

Moulded case and miniature circuit breakers

Moulded case breakers: To AS 60947.1 and AS 60947.2.

Miniature circuit breakers: To AS/NZS 60898.1 or AS/NZS 3111.

Operation: Independent manual operation including positive ON/OFF indicator.

Trip type:

- Moulded case breakers: Required.
- Miniature circuit breakers: Fixed thermal, fixed magnetic.

Isolation facility: Required.

Current limiting:

- Moulded case breakers: Required.

Mounting: Mount circuit breakers so that the ON/OFF and current rating indications are clearly visible with covers or escutcheons in position. Align operating toggles of each circuit breaker in the same plane.

Utilisation category: Moulded case breakers:

- Final subcircuits category: Category A.
- Mains and submains: Category B.

Trip settings: Set as documented, seal, and label.

Trip units: Connect interchangeable and integrally fused trip units so that trip units are not live when circuit breaker contacts are open.

Fuses with enclosed fuse links

Standards: To AS 60269.1, AS 60269.2.0 and AS 60269.2.1.

Fuses with fuse-links for the protection of semiconductor devices: To AS 60269.4.0.

Fuse links: Enclosed, high rupturing capacity type mounted in a fuse carrier.

Breaking range and utilisation category:

- Distribution/general purpose: gG.
- Motors: gM.

Fuse-holders: Mount fuse-holders so that fuse carriers may be withdrawn directly towards the operator and away from live parts. Provide fixed insulation which shrouds live metal when the fuse carrier is withdrawn.

Barriers: Provide barriers on both sides of each fuse link, preventing inadvertent electrical contact between phases by the insertion of screwdriver.

Spare fuse links: Provide 3 spare fuse links for each rating of fuse link on each assembly. Mount spares on clips within the spares cabinet.

Spare fuse holder carriers: Provide 3 spare fuse holder carriers for each size of fuse holder carriers on each assembly. Mount spares on clips within the spares cabinet.

Busbar mounted fuse holders: Provide fuse carriers with retaining clips, minimum fuse holder 32 A.

Current transformers (protection)

Standard: To AS 60044.1.

Type: Cast resin encapsulated window type with busbar clamping devices.

Rated short time current: At least the short time current equivalent to the assembly fault level.

Rated short-time: At least the maximum time setting of the related protective relay. Minimum 1 s.

Rated primary current: Equal to assigned current rating of the associated functional unit.

Rated secondary current: 5 A. Connect star point to earth.

Interposing transformers: Provide as recommended by the protective relay manufacturer.

Characteristics: Conform to the recommendations of the protective relay manufacturer.

Test links: Provide test terminals and current transformer secondary shorting links in accessible positions within instrument panels. Provide a set of DIN-type rail mounted test links, consisting of screw clamped slide links and earth links, for each current transformer group.

Installation: Install transformers to permit easy removal.

Removable links: Provide removable links of minimum lengths for transformers fitted on busbar systems.

Markings: Mount transformers in the assembly enclosure, so that polarity markings and nameplate details are readily viewed right side up without removing the transformers.

Instruments and meters

Accuracy:

1. Indicating Instruments and accessories: ≤ Class 1.5.
2. Thermal maximum demand indicators: Class 3.
3. Electricity meters: Class 0.5.
4. Power factor meters, phase angle meters and synchroscopes: 2 electrical degrees maximum error.
5. Transducers: Class 0.5.

Mounting: Flush mount.

Labels: If associated exclusively with one phase, label meters *RED, WHITE*, or *BLUE* as applicable.

Meter potential protection devices: Group together behind associated meter cover or hinged door, preferably next to current transformer test links.

Accessories: Mount next to associated instruments, inside cabinets.

Transducers: If necessary for transducer operation, provide auxiliary supply. Connect outputs to dedicated rail-mounted isolating type terminals.

Ammeters: Moving iron type oil dampened for motor starter circuits.

Overscale: For ammeters subject to motor starting currents, overscale to at least 5 x full load current.

Selector switches: 4-position type with positions designated R/W/B/OFF. Mount under or beside relevant ammeters.

Maximum demand indicators: Provide a meter in each phase with 15 minute response time. Provide for sealing the reset mechanism. Provide a combination 3-point indicator consisting of an instantaneous red ammeter pointer, a red maximum demand slave pointer with external reset facility, and a white maximum demand pointer.

Instantaneous type: Combined type with bi-metal maximum demand ammeter element and moving iron instantaneous ammeter element.

Thermal type: Combined type with bi-metal maximum demand ammeter element.

Hours-run meters: 6 figure (minimum), horizontal linear digits dial with last digit read-out in 0.1 hour increments.

Contractors

Standard: To AS 60947.4.1.

Type: Enclosed, block type, air break, electro-magnetic.

Poles: 3.

Rated operational current: The greater of:

- Full load current of the load controlled.
- ≥ 16 A.

Mechanical durability: 10 million cycles to AS 60947.4.1.

Electric durability: ≥ 1 million operations at AC-22 to AS 60947.4.1.

Mounting: Mount with sufficient clearance to allow full access for maintenance, removal and replacement of coils and contacts, without the need to disconnect wiring or remove other equipment.

Auxiliary contacts: Provide auxiliary contacts with at least one normally-open and one normally-closed separate contacts with rating of 6 A at 230 V a.c., utilisation category: AC-1.

Slave relay: If the number of auxiliary contacts exceeds the number which can be accommodated, provide separate slave relays.

Control devices and switching elements

Standards: To AS 60947.1 and AS 60947.5.1.

Switching elements:

1. Electrical emergency stop device with mechanical latching function: To AS 60947.5.4.
2. Electromechanical control circuit devices: To AS 60947.5.1.
3. Proximity switches: To AS 60947.5.2.

Rotary switches: Cam operated type with switch positions arranged with displacement of 60º.

Off position: Locate at the 12 o'clock position. Test positions must spring return to off position.

Rated operational current: At least 6 A at 230 V a.c.

Escutcheon plates: Provide rectangular plates securely fixed to the assembly panel. Identify switch position and function.

Time switches:

1. Type: 7 day fully programmable with holiday override function.
2. Daylight saving switch: Required.
3. Mains failure operation: 100 hour minimum operating capacity.

4. Contact rating: ≥ 16 A at 230 V a.c. resistive load.

5. Construction: Provide readily accessible means of adjustment. Provide operational settings which are clearly visible when switch cover is fitted.

6. Dial: Digital with hour and minute display.

Override switch (manual): Required.

Control relays:

1. Standards: To AS 60947.5.1.

2. Operation: Suitable for continuous operation. Provide relays selected in conformance with the **Control relay selection table**.

3. Construction: Plug-in types. Receptacle bases with captive clips which can be operated without using tools.

4. Contact elements: Electrically separate, double break with silver alloy, non-welding contacts.

5. Configuration: For standard relays, provide assemblies with ≥ 2 sets of contacts and expandable to 8 sets of contacts in the same assembly. Provide at least one normally-open and one normally-closed contact.

6. On site conversion: Provide contact blocks readily convertible to either normally-open or normally-closed contacts.

Control relay selection table

Relay type	**Minimum mechanical life (million operations)**	**Base**	**Minimum contact rating**	**Inter-changeable**	**Minimum number of contact elements**
1	5	Plug-in	$1.25I_L$	Yes	2
2	10	Plug-in	5 A at 240 V	Yes	2
3	10	Fixed mounting	5 A at 240 V	Yes	4

Time delay relays:

1. Adjustable range: Adjustable over the full timing range with timing repeatability within ±12.5% of nominal setting.

2. Electronic relays: Incorporate light emitting diodes indicating energisation states of relays.

3. Pneumatic relays: Provide sealed chamber type with internal circulating air with linear calibrated time adjustment.

Synchronous relays

General: Provide synchronous motor drive type relay fitted with anti-stalling device which protects gearing during normal operation.

Phase failure relays

General: Provide separate solid-state phase failure relays which release at the following:

- < 85% of normal voltage.
- Single phase failure.
- Reverse phase sequence after an appropriate time delay.

Sensing circuit: To reject induced voltage spikes and disturbances with frequencies other than 50 Hz.

Back-up protection: Provide high rupturing capacity fuses to each phase.

Push-buttons: Oil-tight, minimum 22 mm diameter, or 22 x 22 mm.

Rated operational current: At least 4 A at 240 V a.c.

Emergency stop devices with mechanical latching: To IEC 60947-5.5.

Marking: Identify functions of each push-button. For latched STOP or EMERGENCY STOP push-buttons, provide label with instructions for releasing latches.

Semiconductor controllers and contactors

General: Provide semiconductor controllers and contactors rated for the characteristics of the controlled load.

Standard: To AS/NZS 3947.4.3.

Indicator lights

Standard: To AS 60947.5.1.

Incandescent indicators: Incandescent oil tight type minimum 22 mm diameter or 22 x 22 mm.

Lamps: Changeable from front of panel without removing the holder.

Lamp rating: 1.2 – 5 W.

Neon indicators: 240 V, 12 mm diameter with in-built resistor.

LED indicators: 12 or 24 V as necessary, in corrosion-resistant bezel, nominal 5 mm diameter.

Press-to-test:

1. Compartments/subsections with < 5 indicating lights: Provide each indicating light with a fitted integral press-to-test lamp actuator.

2. Compartments/subsections with ≥ 5 indicating lights: Provide a common press-to-test lamp push-button.

Indicating counters

General: Provide the following:

1. At least 6 digits.
2. Digits at least 3.5 mm high.
3. Continuous duty rated.
4. Non-reset type.
5. 500 V surge diverters.

Audible alarm devices

Sound level: The greater of the following:

1. 65 dB(A) at 1 m.
2. 15 dB(A) above ambient sound levels at any location in designated areas.

Extra-low voltage transformers

General: Provide the following:

1. Centre tap on secondary winding.
2. Primary and secondary windings wired out on opposite sides of transformer case.
3. Primary and secondary windings separated by means of an earthed screen wired out to an insulated terminal.
4. Transformer rating ≥ 125% of maximum output load, taking account of degree of ventilation and ambient temperature within assembly, and supplied load.

Anti-condensation heaters

Rating: Provide heaters rated at not less than 20 W/m^2 of total external area including top of weatherproof enclosure.

Type: Black heat type which may be touched without injury, mechanically protected and thermostatically controlled.

Spares cabinet

General: Provide a spares cabinet with main name plate, labelled shelves and non-lockable door. Size for storing racking handles, special tools, spare lamps, spare fuse links and other equipment necessary for satisfactory assembly operation.

Location: Either of the following:

1. Incorporated into assembly enclosure.

2. Wall mounted in main switchroom.

Finish: To match assembly.

7.5.2 INSTALLATION

Marking and labelling

Provide labels including control and circuit equipment ratings, functional units, notices for operational and maintenance personnel, incoming and outgoing circuit rating, sizes and origin of supply and kW ratings of motor starters.

Labels on assembly exteriors:

1. Manufacturer's name: Required.

2. Assemblies: Label with essential markings.

3. Designation labels: For other than main assemblies, provide designation label stating source of electrical supply. Identify separate sections of enclosures.

4. Assembly controls: Label controls and fault current limiters, including the following:

   - Circuit designation for main switches, main controls and submains controls.
   - Details of consumers mains and submains.
   - Incoming busbar or cable rating to first tee-off.
   - Fuse link size.

Labels on assembly interiors: Provide labels for equipment within assemblies. Locate so that it is clear which equipment is referred to, and so that lettering is not obscured by equipment or wiring.

Moulded case circuit breakers: If circuit breaker manufacturer's markings are obscured by operating handle mechanisms or motor operators, provide additional markings open to view on, or next to, the circuit breaker.

Arrestors: Label each group of primary arrestors, stating their purpose and the necessary characteristics.

Danger, warning and caution notices:

1. Busbars: If polymer membrane coating is used without further insulation, provide warning notices on the front cover near the main switch or local main switch and on rear covers, indicating that busbars are not insulated.

2. Fault current limiters: In assembly sections containing fault current limiter fuses provide caution notices fixed next to the fault current limiters, stating that replacement fuse links are to match the installed fuse link ratings, make and characteristics. Provide separate label stating make and fault current limiting fuse ratings.

3. Externally controlled equipment: To prevent accidental contact with live parts, provide warning notices for equipment on assemblies not isolated by main switch or local main switch.

4. Stand-by power: Provide warning notices stating that assemblies may be energised from the stand-by supply at any time.

5. Anti-condensation heaters: To prevent accidental switching off, provide caution notices for anti-condensation heaters.

6. Insulation and shrouding: For insulation or shrouding requiring removal during normal assembly maintenance, provide danger notices with appropriate wording for replacement of insulation shrouding before re-energising assemblies.

7. Positioning: Locate notices so that they can be readily seen, next to or, if impracticable, on busbar chamber covers of functional units and behind the front cover of functional units. Provide circuit identification labels in the cabling chamber of each functional unit, located next to external terminations.

Marking cables: Identify the origin of all wiring by means of legible indelible marking.

Identification labels: Provide durable labels fitted to each core and sheath, permanently marked with numbers, letters or both to suit the connection diagrams.

Multicore cables and trefoil groups: Identify multicore cables and trefoil groups at each end with durable non-ferrous tags clipped around each cable or trefoil group.

7.6 MOTORS AND STARTERS

7.6.1 GENERAL

Submissions

General

Calculations: Submit calculations supporting motor selection in relation to load characteristics.

Technical data: Submit manufacturers technical data for all motors, starters and protection equipment.

Variable speed drives: Submit reports of type tests for variable speed drives.

Calculations

Submit calculated input power factor and harmonic content for variable speed drives.

7.6.2 PRODUCTS

7.6.2.1 Motors

General

General: Provide motors selected in conformance with AS 60034.1, the application load characteristics, motor manufacturers' recommendations and the following:

- Motors ≥ 0.75 kW: Three phase.

Rating

Standard: To AS 60034.1.

Maximum power rating: The greater of the documented minimum motor size and next preferred standard frame size above the maximum load of the driven equipment.

Duty: ≥ S1.

Class: 'continuous running'.

Speed: ≤ 1500 r/min.

Starting Performance

Minimum designation: Design N to AS 60034.12.

Speed and torque: Provide motors selected to ensure the motor develops sufficient torque relative to the starting load of the driven machine such that it runs up to full speed steadily and within a time period compatible with motor winding temperatures, class of insulation and rating of the starting equipment.

Efficiency

Motors documented as high efficiency: To AS/NZS 1359.5 Table A3 or Table B3.

All other motors: To AS/NZS 1359.5 Section 2.

Environment

Site operating conditions: To AS 60034.1.

Electrical operating conditions: To AS 60034.1.

Enclosure

General: Provide enclosures appropriate to the environment in which the motor operates.

Motor enclosure classification: ≥ IP44 to AS 60529 and AS 60034.5.

Cooling

Standard: To AS 1359.106.

Classification: ≥ IC01.

Marking

Terminals: To AS 60034.8.

Mounting

Standard: IM classification to AS 60034.7.

Noise

Standard: To AS 60034.9.

Vibration

Standard: To AS 1359.114.

Grade: ≥ N (normal).

7.6.2.2 Motors for variable speed drive

General

If supplied from variable speed drives, provide motors that, in addition to the above, comply with the following:

1. Standard: To AS 61800.2.

2. Cooling: Select cooling system and internal wiring to maintain the required thermal conditions under all operating situations including running at low speeds corresponding to 10 Hz.

3. Insulation: Select insulation of wiring and components to withstand the pulse voltages generated by the VSD controller, and its associated filter and using a nominal cable length of 30 m, without a reduction in the guaranteed motor service life.

4. Noise: Comply with acoustic and electrical noise limits under all operating situations.

5. Mounting: Comply with vibration limits under all operating situations.

7.6.2.3 Starters

Standard

General: To AS 60947.1 and AS 60034.12.

Electromechanical motor starters: To AS 60947.4.1.

Semiconductor motor starters: To AS 60947.4.2.

Selection

General: Provide motor starters selected according to the following:

1. Electricity distribution network limitations for starting currents and voltage flicker.

2. Torque requirements for the motor load.

3. Heating effects on the motor.

4. Voltage drop during start due to starting currents.

5. Time required to accelerate from rest to full speed.

6. Number of starts per hour.

Performance

Rated operational current: At least the full load current of the load controlled.

Rated duty: Intermittent class 12.

Utilisation category: AC-3.

Mechanical durability: ≥ 3 million cycles to AS 60947.4.1.

Electric durability: ≥ 1 million operations at AC-3 to AS 60947.4.1.

Mounting: Mount with sufficient clearance to allow full access for maintenance, removal and replacement of coils and contacts, without the need to disconnect wiring or remove other equipment.

Auxiliary contacts: Provide separate auxiliary contacts with at least one normally-open and one normally-closed contacts with rating of 6 A at 230 V a.c., utilisation category: AC-1.

Slave relay: If the number of auxiliary contacts exceeds the number which can be accommodated, provide separate slave relays.

Direct-on-line starters

Type: Direct-switching electromagnetic contactor.

Reversing starters

General: Comply with **Direct-on-line starters** and the following:

1. 2 main line contactors, mechanically and electrically interlocked to prevent simultaneous closure.

2. Time delay relay with nominal 0 to 30 s adjustable time delay, to prevent plugging of the motor.

3. Emergency stop push-button.

Multi-speed starters

General: Comply with **Direct-on-line starters** and the following:

1. Mechanically and electrically interlocked.

2. Time delay relay with nominal 0 to 30 s adjustable time delay.

Star-delta starters

General: Provide electromagnetically operated control gear incorporating the following:

1. Main line contactor or equivalent.

2. Star and delta contactors mechanically and electrically interlocked to prevent simultaneous operation.

3. Time delay relay with nominal 0 to 30 s adjustable time delay, to control the star to delta switching contactors.

Secondary resistance starters

Type: Rheostatic rotor starters.

Number of accelerating steps: At least 3.

Construction: Mount air cooled resistors in separated ventilated enclosures matching appearance of other starter cabinets. Label resistor tappings and identify connecting wiring with heat resisting tags.

Overheat protection: Provide a thermostat or thermistor operated relay to isolate starter in the event of resistor overheating. Locate measurement device in optimum position to detect abnormal heating.

Overheat indication: Warning light in starter cabinet.

Semiconductor starters

Standard: To AS 60947.4.2.

Characteristics: Provide gate firing circuits in each phase and over-temperature protection for the starter. Provide automatic voltage control to suit load, variable control of starting current and torque, adjustable starting current limit, and silicon control rectifier (SCR) loss-of-phase protection.

Voltage regulation: Electronically controlled thyristors.

Part winding starters

General: To suit requirements of the machine manufacturer. Provide suitable motor protection devices.

7.6.2.4 Motor protection

General

Provide over-current protection with manual reset giving overload protection in each phase of supply as part of the equipment assembly for each motor starter.

Standard: To AS 60034.11.

Contacts: Provide at least one normally-open and one normally-closed set of contacts rated at the starter control circuit voltage and minimum 4 A. Connect contacts to open the starter at the setting temperature.

Utilisation category: AC-11.

Mounting: Ensure relays are not affected by the shock of mechanical contactor operation. Provide sufficient clear space for the disconnection, removal and replacement of heaters, without disconnecting other equipment and wiring.

Single phase motor protection

General: Provide overload units matching the motor heating curve characteristics.

3-phase motor protection

General: Provide thermal overload protection relays for each motor. Provide the following:

1. Triple pole relays with differential trip bar operation for single phase protection, and ambient temperature compensation.

2. Thermal overloads connected directly to contactor by means of proprietary links, except where operated separately by current transformers.

Thermal overload

General: Provide each motor with overload protection.

Motors ≥ 22 kW: Fit embedded winding temperature thermistors complying with AS 60947.8 in each phase and connect to a protection relay that trips the starter in the event of over temperature. Match trip operating temperature to motor winding insulation classification.

Multi-speed starters: Separate thermal overload protection for each speed configuration.

Star-delta starters: Triple pole thermal overload relay, fitted to line contactor. If overload is connected into motor phase winding circuits, provide a name plate fixed to starter, stating full load current of motor phase winding.

Thermal protection

Standard: AS 60947.8.

Thermistor control unit: Compatible with thermistor installed in the motor.

Type: Automatic reset following power failure. Arrange the circuit so that thermistor failure, failure of other control system components, or excessive winding temperature, causes the motor circuit to trip.

Reset: Manual, to restore the motor circuit when tripped due to excessive winding temperature.

Light emitting diode indication: Provide on the thermistor control unit, to indicate that circuit is in normal operating mode.

Electronic motor protection relays

Standard: AS 60947.4.1.

Characteristics: Provide the following:

1. Single phasing protection and phase sequence protection.
2. Thermal overload protection.
3. Loss of load protection.
4. Excessive motor run-up and stall protection.
5. Earth fault protection.
6. Adjustable settings of protection parameters: LED indication of fault conditions.
7. Manual reset.
8. One normally-open and one normally-closed set of auxiliary contacts with minimum current rating of 4 A at 240 V a.c.
9. Facilities for relay testing.

Current transformers

General: Saturating at 10 to 15 times full load current, Class 10P. Provide adjustment facilities allowing matching of current transformer characteristics.

Programmable electronic motor protection relays

Characteristics: Provide the following:

1. Programmable micro-processor based protection: Comply with **Electronic motor protection relays**.
2. Diagnostic data gathering and retrieval to determine the cause of shut-down.
3. Interrogation and display of data to give actual running conditions at time of interrogation.
4. Non-volatile memory retaining program and data upon loss of power.

5. RS422 communications port.

6. Programming key pad.

7. Software for communications with IBM-compatible personal computers.

7.6.2.5 Variable speed drives

Standard

General: To AS 61800.2 and AS 61800.3.

Type

General: Microprocessor controlled, solid-state electronic type, providing motor speed control of 3 phase squirrel cage induction motors by means of stepless variable frequency, variable voltage pulse width modulated (PWM) output.

Application: Suitable for the documented applications.

Selection

General: Provide variable speed motor drive controllers selected for the following:

1. Rating: Continuously rated to suit the full load current stated on the motor nameplate and the length and type of cable feeding the motor.

2. Service conditions: To AS 61800.2 Section 4.

3. Speed ranges: Suitable for the load duties.

4. Control deviation band: To suit the controls functional specification.

Design: Provide the following:

1. Soft start (initially start motors on low speed).

2. Adjustable maximum current limit.

3. Automatic reset/restart of system after removal of fault or power failure condition. If the number of reset/restart attempts is limited for safety and equipment protection, provide for safe shut down and manual restart in the event of an unsuccessful attempt at the reset/restart sequence.

4. Ability to immediately restart a motor following momentary interruption of supply, even if the motor is rotating, or rotating in the reverse direction.

Protection: Provide protection against:

1. Instantaneous power failure.

2. Instantaneous over current.

3. Internal and external overload.

4. Under and over voltage.

5. Over temperature of the controller.

6. Earth fault.

7. Contact with live parts without the removal of fixed covers or panels.

Motor protection:

General: Provide automatic, electronic motor thermal overload protection facility wherein the tripping time is based on the motor's running frequency, actual motor current, operating time, and the rated current.

Motors ≥ 22Kw: Provide PTC thermistor input to initiate motor shutdown under fault conditions

Controls

Provide facilities for local display and control, including the following:

1. Indication of run condition, motor speed or output frequency, input control parameters, output current and voltage, and alarm conditions.

2. Indication of power on, zero speed, enable, earth fault, short circuit, over current, under voltage, over temperature and remote trip.

3. Facilities for automatic/off/manual control.

4. Local and remote analogue input, to control frequency output of controller when in manual or automatic mode.

5. For remote control, interfaces for analogue input and output associated with speed control, start/stop, and voltage free contacts for alarm fault indication.

Harmonics and EMC

Provide integrated harmonic suppression filters to limit the harmonics to within the value prescribed by the electricity distributor for the motor load and environment.

Standard: To AS/NZS 61000 and AS 61800.3 Category C1 for the actual length and type of cable feeding the motor.

Authorities: Comply with the requirements of the Australian Communications Authority.

Installation

Switchboard mounting: Install each controller, together with associated equipment, in separate ventilated subsections of AS 60034.7.

The motor control switchboard with hinged door shall meet the level of separation, ventilation and screening for the overall enclosure.

Wall mounting: Install in an IP54 rated enclosure.

Testing

Routine tests: Standard separate device and power drive system tests to AS 61800.2 and AS 61800.3.

Site tests: Test input power factor and harmonic content on completed installation.

SECTION 8 - COMMISSIONING AND MAINTENANCE

8.1 MECHANICAL COMMISSIONING

8.1.1 GENERAL

Provide commissioning of all mechanical systems. Submit proposed methods for air balancing and water balancing including (blank) tests sheets for approval prior to commencing the commissioning works. The following procedures listed below are considered as a minimum. Expand the commissioning procedure as necessary to achieve the nominated performances. Ensure all safety precautions and procedures are implemented during commissioning.

8.1.1.1 Standards

Measurement of fan and duct air quantities > 1000 L/s: To ISO 5802.

Testing, balancing and commissioning except fan and duct air quantity measurement: To ASHRAE STD 111 and CIBSE CCA, CIBSE CCB, CIBSE CCC, CIBSE CCR and CIBSE CCW.

The National Environmental Balancing Bureau (NEBB) in the United States also publishes procedures for use by its members of which there are a small number in Australia.

Fire operation of air handling systems: To AS 1668.1.

Orifice plates and venturi meters: To BS 1042.

Microbial control: To AS/NZS 3666.1.

Pressure equipment: To AS/NZS 3788.

8.1.1.2 Related tests

Failure to meet documented performance: Identify and correct the cause of failure and repeat the test.

Provide demonstrations and tests for witnessing by the statutory authorities when required. Complete testing of systems before witness testing by the statutory authorities.

Provide assistance to other trades for testing related non-mechanical systems.

8.1.2 COMMISSIONING

8.1.2.1 General

When the installation is complete, commission the installation. Make the adjustments necessary to achieve the designated performance under continuous operating service conditions, including balancing, setting the controls, checking the operation of overload and safety devices, and correcting malfunctions.

8.1.2.2 Reports

Submit reports indicating observations and results of tests and compliance or non-compliance with requirements.

8.1.2.3 Notice

Give sufficient notice for inspection to be made of the commissioning of the installation.

8.1.2.4 Starting up

Coordinate schedules for starting up of various systems and equipment. Give 5 working days notice before starting up each item.

Before starting, verify that each piece of equipment has been checked for proper lubrication, drive rotation, belt tension, control sequence, circuit protection or for other conditions which may cause damage.

Verify that tests, meter readings, and documented electrical characteristics agree with those required by the manufacturer.

Verify wiring and support components for equipment are complete and tested.

Manufacturers' representatives: If individual technical work sections require the attendance of a manufacturer's representative, have the manufacturers' representatives present on site to inspect and check and/or system installation before starting up, and to supervise placing equipment and operation.

Starting up: Execute starting up under supervision of manufacturers' representative and appropriate contractors' personnel, in accordance with manufacturers' instructions.

Report: Submit a report demonstrating that equipment has been properly installed and is functioning correctly.

8.1.3 INSTRUMENTATION

8.1.3.1 Calibration and certification

Use only instruments that have been calibrated by a Registered testing authority. Provide copies of certification if requested.

The maximum period since last calibration shall be as recommended by manufacturer but ≤ 12 months.

8.1.3.2 Air quantity at diffusers, outlets and grilles

Hood adjustment factors: Determine adjustment factor for each hood and associated anemometer by one of the following methods:

1. Certified by a Registered testing authority for the type of diffuser or grille and direction of air flow being measured.

2. Determined by duct pitot traverse for the particular type of diffuser or grille and direction of air flow being used on the project.

The instruments shall have the following characteristics:

1. Accuracy: Better than ± 5% of measured value.

2. Resolution: Better than 1% of measured value.

3. Range: Minimum measured velocity for instrument not more than 50% of measured velocity.

8.1.3.3 Total system air flow

For systems handling over 1000 L/s measure total system air quantity to ISO 5802.

8.1.3.4 Air pressures and differential pressures

Instrument specifications shall be as follows:

1. Pressures ≤ 50 Pa: Electronic meter or inclined manometer with 50 Pa full scale, accuracy better than 5% full scale.

2. Pressures > 50 Pa: Electronic meter, mechanical meter or inclined manometer with full scale not more than 400% measured value, accuracy better than 2.5% full scale.

8.1.3.5 Temperature

Air temperature instruments specifications:

- Accuracy: ± 0.2 K or better at measured value.

Instrument specifications for other temperature applications:

- Accuracy: ± 0.5 K or better at measured value.

- Scale divisions (mercury-in-glass): 1.0 K or better.

8.1.3.6 Electrical

Instrument specifications:

1. Voltage < 600 V ac: Accuracy ± 3% of full scale.

2. Voltage < 30 V dc: Accuracy ± 3% of full scale.

3. Currents < 100 A: Accuracy ± 3% of full scale.

4. Maximum period between calibration: As recommended by manufacturer but not more than 6 months.

8.1.3.7 Rotational speed

Instrument specifications:

1. Accuracy: ± 5% of measured value.

2. Maximum period between calibration: As recommended by manufacturer but not more than 24 months.

8.1.3.8 Recording instruments

Specifications for instruments collecting measured values over time:

1. Accuracy: At least equal to that specified for the corresponding physical parameter above.

2. Type: Electronic data logger with appropriate sensors or thermohydrograph.

Thermohydrographs: Charge sensing element before use as recommended by the manufacturer.

8.1.4 AIR BALANCING

8.1.4.1 General

Balance each air handling system.

Balancing is complete when all the following conditions are met:

1. All air quantities are within the tolerances in **Air quantity tolerance table** below.

2. Each air quantity measured deviates by less than the instrument accuracy from of the previous reading on the same component with the same instrument.

3. Resistance across the cooling coil bank (if present) is equal to the wetted coil resistance.

4. Resistance of the filter bank (if present) is equal to that of the filter when fully loaded with dirt.

5. For fans with variable speed drives, the frequency to the motor is ≤ 50 Hz.

6. At least one outlet on each branch has its damper at the minimum pressure drop position.

7. At least one sub-branch damper is at the minimum pressure drop position.

8. At least one branch damper is at the minimum pressure drop position.

9. The fan speed or pitch angle is at the lowest value consistent with the above.

8.1.4.2 Air quantity tolerances

Balance air handling systems to the designated air quantities within the tolerances in the **Air quantity tolerance table**. For the purposes of the **Air quantity tolerance table** the following definitions apply:

1. Terminal: A supply, return or exhaust diffuser, grille or equivalent device discharging air into, or drawing air from, a space.

2. Sub-branch: A duct connected to one or more terminals.

3. Branch: A duct with no terminals connected to it.

4. Total air quantity: The sum of air flows to the connected terminals, branches or sub-branches under the conditions of measurement.

8.1.4.3 Air quantity tolerance table

System type	Terminal air quantity tolerance	Branch air quantity tolerance	Total air quantity tolerance
Low velocity supply, return or exhaust system where all terminals on any one sub-branch serve the same space	+20% -0%	+10% -0%	+10% -0%

System type	Terminal air quantity tolerance	Branch air quantity tolerance	Total air quantity tolerance
Low velocity supply, return or exhaust system where the terminals on any one sub-branch serve more than one space	+15% -0%	+10% -0%	+10% -0%
Supply systems for induction units	+5% -0%	+5% -0%	+10% -0%

8.1.4.4 Measurement methods

Total and branch air quantities > 1000 L/s: Measure to ISO 5802.

Other air quantities: Use balancing and measurement methods recommended by ASHRAE or CIBSE.

Do not use the following methods for air quantity measurement:

1. Coil, damper or filter traverse using any kind of instrument.
2. Measurement using an instrument operating with air flow in the reverse direction to that for which it has been certified.
3. Air quantity measurement derived from fan curves or fan performance tables.

8.1.4.5 Preparation for air balancing

Before starting air balancing make sure that:

1. All building work that may affect the air balance is complete. Make sure that:
   - All ceiling tiles are in place.
   - All doors are hung and door grilles (if applicable) are installed.
   - All doors and windows are open or shut consistent with their normal state.
   - The building is airtight.
   - The builder's work ducts, shafts and ceiling plenums are sealed airtight.
2. All ductwork complete and clean.
3. There are no air leaks that can be felt. Check for leaks through doors, access panels, penetrations and joints in air handling units.
4. Flexible duct is installed as documented and has not been damaged.
5. All fire and balancing dampers are open.

6. All interrelated air handling systems are complete and operating concurrently.

7. Fans, coils filters and other mechanical components are complete and operating correctly.

8. All electrical components including overloads and safety devices are complete and operating correctly.

9. All other related work is complete and operating correctly.

8.1.4.6 Additional adjustment of air quantities

Notwithstanding that air quantities may have been measured and are within tolerance. If so directed, adjust space air quantities to:

1. Minimise drafts.

2. Achieve temperatures in individual rooms or parts of rooms that are within the stated design conditions.

If air quantities are altered after submission of air balance reports, resubmit reports showing new values.

8.1.4.7 On completion of air balancing

When air balancing is complete, perform the following:

1. Mark final position of dampers.

2. Seal test holes in ductwork.

   - Duct pressure class ≤ 500: Rubber or plastic plugs.

   - Duct pressure class > 500: Cover plates of same material as the duct.

3. Set system into normal operation.

4. Submit air balance reports.

8.1.5 FIRE MODE OPERATION

Test all systems required to operate in fire mode to AS 1668.1.

Test air handling systems for correct operation in conjunction with fire protection and other related systems.

Reset: Verify that all systems return to normal operating mode after fire mode operation.

Fire and smoke dampers shall be commission to AS 1682.2. Test that fire and/or smoke dampers close fully with fans operating.

Timing: Complete testing before practical completion.

8.1.6 AIR BALANCE REPORTS

Include the following on the air balance reports:

1. Date, time and place of test.

2. Instrumentation used and its date of calibration.

3. Name, position and signature of person responsible for test.

4. Ambient temperature and/or other relevant factors.

5. For each terminal grille and diffuser:

    - Grille or diffuser reference number as shown on the shop drawings. List outlets on a branch by branch basis.

    - Design air quantity.

    - Measured value (e.g. L/s, m/s).

    - Hood or instrument factor.

    - Grille or diffuser manufacturers area factor if applicable.

    - Site measured air quantity in L/s calculated from the above.

    - Measured air quantity as a percentage of design air quantity.

    - Sum of measured branch and system air quantities and percentage of design.

6. For each fan:

    - Fan designation and location.

    - Total air quantity measurement method.

    - Location of measurement point.

    - Simulated wet cooling coil pressure drop and dirty filter pressure drop.

    - Design air quantity.

    - Pitot readings (if used) or other measured values used to independently determine total fan air quantity.

    - Site measured air quantity in L/s calculated from the above.

    - Measured air quantity as a percentage of design air quantity.

    - Measured air quantity as a percentage of the sum of the individual diffuser and grille air quantities.

    - Blade pitch and/or fan speed as applicable.

    - Variable speed drive frequency (if VSD is installed).

    - Measured motor current and name plate full load current.

    - Show the final operating point on the fan characteristic curve.

7. Static pressure differentials across:

    - Each filter bank when clean.

    - Each cooling and heating coil.

- Each fan.

8. Duct static pressure at:

   - Entry to filters.

   - Entry to each fan.

   - At duct discharge from air handling unit.

   - At each riser connection for supply and return systems serving multiple floors.

8.1.7 AUTOMATIC CONTROLS

Test all controls hardware and software for correct operation and calibrate all sensors to within the documented accuracy of the sensor.

8.1.8 SAFETY CONTROLS

Test each safety control and facility by simulating the unsafe condition that the control is intended to protect against.

Ensure that monitoring and safety measures are in place for the test to protect personnel from injury and the building and equipment from damage.

8.1.9 PLANT OPERATION PERIOD

Provide a plant operation period after the installation has passed completion tests and before the date for practical completion.

Plant operation period: ≥ 5 days.

Plant operation: Operate the mechanical systems continuously during the plant operation period. Provide one or more experienced operators in constant attendance in working hours and on call at other times to monitor the plant operation and make necessary adjustments to keep it operating properly.

8.1.10 COMPLETION TESTS

Carry out completion tests.

8.1.10.1 Heating and airconditioning performance tests

In addition to balancing and commissioning, test performance of air conditioning systems during the maintenance period.

Instrumentation: Electronic data logger with temperature and humidity sensors or thermohydrograph. Conform to **Instrumentation**.

Automatic control system: If the automatic control system has been documented to have facilities for logging sensed values, provide trend logs of sensor values over the same periods.

Performance: Record dry-bulb and relative humidity at each location continuously for 2 separate periods of at least 24 hours.

Reports: Provide graphical printout of values recorded by instrument together with control system log graphs where this facility is provided.

8.1.10.2 Motors

Motor-driven equipment performance tests: Test for performance. Adjust thermal overloads for actual current and record measured current and overload settings.

8.1.11 CERTIFICATION

Provide certification that the installation complies in all respects with the contract documents.

Provide certification of compliance with the relevant statutory requirements.

8.2 BUILDING TUNING PERIOD

During the warranty period, the Mechanical Contractor shall carry out regular preventative maintenance on a monthly basis. The maintenance routines shall ensure proper operation of the equipment in accordance with manufacturer's requirements, AIRAH Publication Maintenance DA 19 and good trade practice. The Mechanical Contractor shall provide all miscellaneous materials required in carrying out the works

- Verification that systems are performing to their design potential during all variations in climate and occupancy.
- Optimisation of time schedules to best match occupant needs and system performance.
- Alignment of the systems' operation to the attributes of the built space they serve.
- On-going training of existing personnel and training of new personnel.
- Monitor complaints received from occupants/tenants and determine whether the problem lies in the discrepancy between the predicted performance measured against actual performance or whether the complaint indicates a need to re-evaluate the design intent.

8.3 MAINTENANCE

8.3.1 GENERAL

Provide a detailed plan for carrying out routine inspection, testing and maintenance of the mechanical systems and associated components during the defect liability period.

Provide maintenance of all mechanical systems. The following procedures listed below are considered as a minimum. Expand the maintenance procedures as necessary of the proper and efficient operation of the mechanical systems. Ensure all safety precautions and procedures are implemented during maintenance.

Maintenance period shall be [12 month starting from the practical completion date] and shall be performed by fully and suitably skilled servicemen.

8.3.1.1 Standards

Air handling system maintenance: Maintain to AS 1851.

Microbial control: Maintain to AS/NZS 3666.2 and AS/NZS 3666.3.

Pressure equipment: Maintain to AS 3873 and Inspect to AS/NZS 3788.

Respiratory protective devices: Maintain to AS/NZS 1715.

8.3.1.2 Inspection

Notice

Inspection: Give notice so that an inspection may be held simultaneously with the end of maintenance period service.

8.3.2 OPERATION AND MAINTENANCE MANUALS

Additional information

Provide operation and maintenance manuals for the whole of the mechanical work. Include the following in addition to that specified in the *General requirements* worksection:

1. Installation description: General description of the installation.

2. Systems descriptions: Technical description of the systems installed, written to ensure that the principal's staff fully understand the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions.

3. Systems performance: Technical description of the mode of operation of the systems installed.

4. Equipment descriptions:

   - Manufacturers' technical literature for equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.

   - Supplements to product data to illustrate relations of component parts. Include typed text as necessary.

5. Operation procedures:

   - Safe starting up, running-in, operating and shutting down procedures for systems installed. Include logical step-by-step sequence of instructions for each procedure.

   - Control sequences and flow diagrams for systems installed.

   - Legend for colour-coded services.

   - Schedules of fixed and variable equipment settings established during commissioning and maintenance.

   - Procedures for seasonal changeovers.

   - If the installation includes cooling towers, a water efficiency management plan.

6. Maintenance procedures:

   - Schedule of normal consumable items, local sources of supply, and expected replacement intervals up to a running time of 40 000 hours. Include lubricant and lubrication schedules for equipment.

   - Schedule of maintenance work including frequency and manufacturers' recommended tests.

   - Instructions for use of tools and testing equipment.

   - Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding.

   - Material safety data sheets (MSDS).

7. Certificates:

- Copies of test certificates for the mechanical installation and equipment used in the installation.

- Test and balancing reports.

- All control system testing and commissioning results.

8. 7 day record of all trends at commissioning.

9. For small systems with no trend logging provisions, omit the last item.

10. Drawings:

    - Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.

    - Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

11. Recommissioning instructions.

12. Prototype periodic maintenance and performance report.

13. Documentation to AS 1851 clause 18.2.4 including the schedule of essential functionality and performance requirements.

14. Prototype periodic maintenance records for compliance with AS 1851 prepared to include project specific details.

15. Schedules to be used for recording recommissioning data so that changes in the system over time can be identified.

16. Instructions and schedules for complying with AS 1851, AS/NZS 3666.2 and AS/NZS 3666.3.

8.3.3 PERIODIC MAINTENANCE AND PERFORMANCE REPORT

General: At the frequency documented, provide a report summarising the maintenance performed and the performance of the mechanical plant in the preceding period. Set out the report in a form that permits comparison with previous reports. Include the following as minimum requirements:

1. Dates and number of site labour hours for programmed maintenance. Exclude travelling time.

2. Dates, number of site labour hours and nature of work for corrective maintenance. Exclude travelling time.

3. Dates and number of site labour hours for defects liability rectification if within the defects liability period. Exclude travelling time.

4. Quantity and type of refrigerant used.

5. Peak load and load profile for chillers.

6. Peak load and load profile for electrical power consumed by mechanical plant.

7. Mechanical plant gas consumption and load profile.

8. List of any motors for which the motor current varied by more than 10% from the current measured during commissioning.

9. Results of recommissioning if scheduled for the period.

8.3.4 MAINTENANCE REQUIREMENTS

Provide all labour and material necessary to maintain the mechanical installation including, but not limited to, filter media, belts, refrigerants, lubricants and all items commonly referred to as consumable.

Report to the principal's designated representative on arriving at and before leaving the site.

8.3.5 MAINTENANCE DURING CONSTRUCTION

During the construction period and until all maintenance and operation manuals have been completed and submitted and all operator instruction is complete, provide all maintenance including but not limited to:

1. Daily operation including starting and stopping of the plant.

2. All routine service tasks.

3. Emergency visits.

8.3.6 CLEANING

General: Progressively clean the interior of pipework, ductwork and air handling components as they are installed. Inspect the interior of dampers and valves on installation and remove obstructions.

Immediately before the date for practical completion:

1. Clean all parts of the installation.

2. Clean interior of switchboards, switchgear, contactors and other electrical contacts.

3. Clean interior or air handling plant.

4. Clean strainer baskets.

8.3.7 CORRECTIVE MAINTENANCE

8.3.7.1 General

Respond to call outs for breakdowns or other faults requiring corrective maintenance. Rectify faults and replace faulty materials and equipment.

Remedial work: Carry out any remedial work, including temporary work, necessary to restore the systems to safe and satisfactory operation. Do not leave site until correct operation has been proved. Do not leave the plant in an unsafe condition.

Temporary work: Promptly replace temporary work with permanent rectification.

8.3.7.2 Contact details

Provide contact details including after hours and emergency mobile and/or pager details to permit notification of emergency conditions.

8.3.7.3 Response time

Attend site for emergency service within the time period documented.

Calculation of response period: Response period starts at the time of notification to the contractors nominated contact point.

8.3.7.4 Failure to respond

Should the contractor fail to respond to site within the period stated in the schedules, the principal may, without incurring any liability or obligation and without limiting any other redress, engage persons other than the contractor to undertake emergency work on the systems. Fully reimburse the principal for any costs incurred.

8.3.8 REGULAR MAINTENANCE

8.3.8.1 General

Make routine service visits at the frequency documented. Service items of equipment in accordance with the maintenance schedules in the operation and maintenance manuals.

8.3.8.2 Frequency of visits

Provide maintenance visits at the following maximum intervals, or comply with the frequency documented if more frequent:

1. Analysis of refrigerant in compressors: 3 months.
2. Air filters: Comply with AS 1324.1 Section 3.
3. Air handling systems within the scope of AS 1668.1 and AS 1668.2: Comply with AS 1851.

8.3.8.3 Notification of defects

When defects in the installation are identified notify the principal in writing.

8.3.8.4 All systems

Provide maintenance work including but not limited to the following:

1. Attend to reported defects and complaints.
2. Check for and repair corrosion.
3. Remove rubbish and clean equipment.
4. Check for and rectify any unsafe conditions.
5. Replace faulty or damaged parts and consumable components.
6. Check anti-vibration supports, brackets and clamps, holding down bolts and flexible connections, for deterioration and for freedom of movement of assembly.
7. Identification of pipes, conduits and ducts: Maintain to AS 1345.
8. Safety signs: Maintain to AS 1319.

8.3.8.5 Fire and smoke dampers

Perform the following tasks: Inspect and maintain to AS 1851.

1. Carry out manufacturers recommended maintenance.

8.3.8.6 Piped systems

Perform the following tasks:

1. Vent air from water systems, drain water from compressed air systems.
2. Check equipment items for operation, calibration, performance compliance, temperature and energy consumption, and record values. Rectify defects.
3. Check water drainage systems for unobstructed flow. Remove obstructions and flush.
4. Rectify all water leaks regardless of size. Clean and make good water damage.
5. Check air handling and water systems for temperature, pressure, flow and leakage. Adjust if necessary and rectify defects.
6. Check condition of insulation and vapour barriers for damage and repair.
7. Check water treatment systems for water condition, chemical dosage, bleed rate and make-up. Supply necessary chemicals.

8.3.8.7 Refrigeration systems

Perform the following tasks:

1. Check refrigeration systems for temperature, pressure including analysis of oil and refrigerant. Record results and rectify defects.
2. Check refrigerant charge by measuring and recording superheat and subcooling. Adjust charge and superheat to manufacturer's recommendations. Record amount of refrigerant added or removed.
3. Hermetic compressors: Analyse refrigerant gas. Determine the acid and moisture content of the gas. Record results.
4. Check refrigeration system controls and adjust if necessary.
5. Check for leaks using electronic leak detector. Rectify leaks.
6. Check air cooled condenser coils for fin damage, dirt or obstruction. Clean and repair.
7. Carry out wet system maintenance required by AS/NZS 3666.2.

8.3.8.8 Drives

General: Perform the following tasks:

1. Check drives and couplings. Rectify faults.
2. Check belt drives for belt wear and tension. Replace worn or broken belts.
3. Check pulley alignment and re-align if out of alignment.
4. Check motors and machinery for excessive operating temperature, bearing noise and excessive vibration. Rectify defects.
5. Lubricate equipment.

8.3.8.9 Automatic controls

General: Perform the following tasks:

1. Check operation and safety controls for variable speed drives. Check and record output frequency. Adjust if incorrect. Rectify defects.

2. Record readings of thermometers, gauges, meters, current draw of motors and heaters, sample readings, control set points and controlled space conditions.

3. Check sensor calibration. Recalibrate if incorrect.

4. Check electrical and control systems, including safety limits for temperature, pressure and humidity. Adjust if incorrect. Rectify defects.

8.3.8.10 Electrical

Perform the following tasks:

1. Check for hot joints, burnt insulation, burn contacts and repair.

2. Check electrical connections for tightness. Tighten loose connections.

3. Check operation of all electrical components. Rectify defects.

4. Check indicating lights and replace defective lamps.

5. Check and record motor currents.

6. Check overload settings. Adjust if necessary.

7. Check and report any changes to controls and wiring.

Standards:

1. Electrical equipment generally: To AS/NZS 3760.

2. Switchboards: To AS 2467.

3. Repair and overhaul of rotating electrical equipment: To AS 4307.1.

8.3.9 END OF MAINTENANCE PERIOD SERVICE

Within one month before the end of the maintenance period, carry out the following service tasks:

1. Undertake all work scheduled to be carried out on an annual basis.

2. Replace air filters if the resistance exceeds 80% of the ‘dirty’ resistance of the filter bank.

3. Undertake work specified in **Recommissioning.**

4. Drain, clean and refill cooling towers, water basins and tanks, and clean screens, strainers, distribution troughs, spray nozzles and drip trays.

5. Drain, dismantle, inspect and reinstate boilers and pressure vessels, to AS/NZS 3788.

6. Remove, clean and inspect water heads at heat exchangers. Clean and inspect heat exchanger pipes, pipe plates and water chests.

7. Clean moisture eliminators and heating and cooling coil surfaces.

8. Remove external scale and corrosion, prepare and repaint the affected surfaces.

9. Provide infra-red scan of switchboards.

8.3.10 STATUTORY CERTIFICATION

Annual certification: Inspect and certify all items required to be inspected annually under statutory requirements including but not limited to air handling systems required for fire operation, boilers and pressure vessels. Submit certification to the principal.

SECTION 9 - SCHEDULE OF EQUIPMENT

9.1 VRF/VRV SYSTEM - INDOOR FAN COIL UNITS

Item No:		FCU-01	FCU-02	FCU-03	FCU-04	FCU-05
Number of Units		1 - off	1 - off	1 - off	1 - off	1 - off
Area Served:		Office 1	Office 2	Meeting Room	Kitchen/Dining	Common & Charge
Unit Type :		Ceiling Cassette	Ceiling Cassette	Ducted	Ducted	Ducted
Total Cooling Capacity/Unit:	kW	1.9	1.7	6.2	6.3	4.9
Sensible Cooling Capacity/Unit:	kW	1.5	1.3	4.1	4.3	3.5
Heating Capacity/Unit:	kW	1.3	0.9	3.6	3.8	2.7
Air Quantity / Unit:	l/s	150	145	320	320	300
Outside Air Quantity / Unit:	l/s	20	20	120	120	80
Manufacturer		Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric
Model		FXZQ25AVM	FXZQ25AVM	FXMQ63PVE	FXMQ63PVE	FXMQ50PVE
Outdoor VRF / VRV System Condenser Number		CU-01	CU-01	CU-01	CU-01	CU-01
Notes.		Heat Recovery	Heat Recovery	Heat Recovery	Heat Recovery	Heat Recovery

Notes:
1. All fan coil units shall be in compliance with NCC Section J and shall use refrigerants with an ODP of zero.
2. All units shall be provided with wired remote control panels.

Item No:		FCU-06	FCU-07	FCU-08	FCU-09	FCU-10
Number of Units		1 - off	1 - off	1 - off	1 - off	1 - off
Area Served:		Gym	Lockers	Medical Store	Admin	Sleeping Pod 1
Unit Type :		Ceiling Cassette	Ducted	Ceiling Cassette	Ceiling Cassette	Ceiling Cassette
Total Cooling Capacity/Unit:	kW	2.6	4.3	3.1	2.7	1.6
Sensible Cooling Capacity/Unit:	kW	1.9	2.7	2.1	2.1	1.4
Heating Capacity/Unit:	kW	1.4	2.8	1.6	1.7	0.8
Air Quantity / Unit:	l/s	217	260	217	217	145
Outside Air Quantity / Unit:	l/s	40	60	30	30	10
Manufacturer		Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric
Model		FXFQ25PVE8	FXMQ40PVE	FXFQ32PVE8	FXFQ25PVE8	FXZQ25AVM
Outdoor VRF / VRV System Condenser Number		CU-01	CU-01	CU-01	CU-01	CU-02
Notes.		Heat Recovery	Heat Recovery	Heat Recovery	Heat Recovery	Heat Pump / VRV4S

Notes:
1. All fan coil units shall be in compliance with NCC Section J and shall use refrigerants with an ODP of zero.
2. All units shall be provided with wired remote control panels.
3. Comms room unit to be cooling only.

Item No:		FCU-11	FCU-12
Number of Units		1 - off	1 - off
Area Served:		Sleeping Pod 2	Comms
Unit Type :		Ceiling Cassette	Ceiling Cassette
Total Cooling Capacity/Unit:	kW	1.7	7.1
Sensible Cooling Capacity/Unit:	kW	1.5	-
Heating Capacity/Unit:	kW	1.1	-
Air Quantity / Unit:	l/s	150	300
Outside Air Quantity / Unit:	l/s	10	-
Manufacturer		Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric
Model		FXZQ25AVM	FTXC71AV1A
Outdoor VRF / VRV System Condenser Number		CU-02	CU-03
Notes.		Heat Pump / VRV4S	Cooling only

Notes:
1. All fan coil units shall be in compliance with NCC Section J and shall use refrigerants with an ODP of zero.
2. All units shall be provided with wired remote control panels.
3. Comms room unit to be cooling only.

9.2 OUTDOOR UNITS

Item No:	CU-01	CU-02	CU-03
Unit Type :	REYQ12TY1	RXYMQ3AV4A	RXC71AV1A
Area Served	All Areas	Sleeping Pods	Comms room
Total Cooling Capacity(kW)	33.8	3.3	7.1
Total Heating Capacity (kW)	19.8	1.9	-
Condenser Air On DB/WBoC:/Heating	36.0 / 21.0 / -1.0	36.0 / 21.0 / -1.0	36.0 / 21.0 / -1.0
Refrigerant	R-410A	R-410A	R-410A
Phase	3	1	1
Sound Power Level SWL	80	69	65
Manufacturer/Type	Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric	Daikin or Mitsubishi Electric (Cooling Only) >50m Refrigerant Pipe Length

Notes:

1. All units to be Daikin VRV or approved equal.
2. All units shall be in compliance with BCA Section J and shall use refrigerants with an ODP of zero.
3. VRV system shall be provided with a touch screen central controller for control and monitoring the indoor fan coil units.

9.3 EXHAUST AIR FANS

Item No:		**EAF - 01**
Area Served:		WCs
Flow Rate:	l/s	550
Estimated Pressure:	Pa	150
Fan Type:		Powerline EC Series
Minimum Motor Size:	KW	0.50
Maximum motor speed:	RPM	1187
Maximum Sound Power Level SWL:	dB(A) re 10^{-12} watts @3m	44
Hz		
63		65
125		67
250		63
500		58
1000		59
2000		58
4000		56
8000		50
Model / Brand		Fantech or Approved Equal
Notes		

All Exhaust Air Fans provided shall be in compliance with BCA Section J

9.4 OUTSIDE AIR FANS

Item No:		OAF - 01	OAF - 02
Area Served:		All Areas	Sleeping Pods
Flow Rate:	l/s	520	20
Estimated Pressure:	Pa	170	50
Fan Type:		Powerline EC Series	Ecowatt Series
Minimum Motor Size:	KW	0.50	0.02
Maximum motor speed:	RPM	1168	1693
Maximum Sound Power Level SWL:	dB(A) re 10^{-12} watts @3m	44	25
Hz			
63		65	48
125		67	40
250		63	43
500		58	43
1000		59	39
2000		58	38
4000		56	37
8000		50	25
Model / Brand		Fantech or Approved Equal	Fantech or Approved Equal
Notes			c/w speed controller

All Outside Air Fans provided shall be in compliance with BCA Section J

9.5 ROOF VENTILATORS

Item No:	RVF - 01 – 06
Number of Units:	6-off
Unit Type:	rotating wind driven roof ventilator
Unit Model number	H900
Area served:	Plant Room
maximum flow rate capacity (m3/s)	0.58
internal diameter (mm)	897
outside diameter (mm)	1096
Weight (Kg)	18.1
Manufacturer	Hurricane -CSR Edmonds
Notes:	Complete with manual operated actuated dampers.

All roof ventilators comply with AS1668.4-2012

9.6 MECHANICAL SWITCHBOARD SCHEDULE

Item No:	**MSSB-01**
Location:	Plant Enclosure
Mounting Type:	Wall Mounted
Entry:	Top
IP Rating:	IP56
Form of Segregation:	2B
Incoming Supply (V/Ph/Hz):	415/3/50
Control Circuit Voltage:	240
Fault Rating:	6kA (AS3000 & AS3439.1)
Main Isolator Size:	(As required)

Connected Equipment:

Ref.	kW	MCA	Ph	Starter	Manual/ Off/Auto Switch	Run/Fault Light	Remarks
CU-01	9.22	21.0	3	SOFT	YES	YES	
FCU-01	0.043	0.3	1	-	-	-	
FCU-02	0.043	0.3	1	-	-	-	
FCU-03	0.138	1.8	1	-	-	-	
FCU-04	0.138	1.8	1	-	-	-	
FCU-05	0.128	1.6	1	-	-	-	
FCU-06	0.033	0.3	1	-	-	-	
FCU-07	0.151	1.4	1	-	-	-	
FCU-08	0.033	0.3	1	-	-	-	
FCU-09	0.033	0.3	1	-	-	-	
CU-02	2.44	16.5	1	SOFT	YES	YES	
FCU-10	0.043	0.3	1	-	-	-	
FCU-11	0.043	0.3	1	-	-	-	
CU-03 / FCU-12	2.37	18.4	1	SOFT	YES	YES	COMMS
OAF – 01	0.16	2.50 FLC	1	EC	YES	YES	
OAF – 02	0.02	0.10 FLC	1	DOL	YES	YES	CW/ SPEED CONTROLLER

Item No:					**MSSB-01**		
EAF – 01	**0.17**	**2.50 FLC**	**1**	**EC**	**YES**	**YES**	

SECTION 10 - DESIGN CRITERIA

10.1 GENERAL

The design criteria specified in this worksection shall be used by the mechanical sub-contractor for the mechanical services systems design.

10.2 CODES AND AUTHORITIES REQUIREMENTS

The Mechanical Services shall be designed in accordance with the following:

1. AS 1668.1 - Fire and Smoke Control in Buildings.
2. AS 1668.2 - Mechanical Ventilation in Buildings.
3. AS/NZS 3666.1 - Air handling and water systems of buildings - Microbial Control.
4. AS3000 and AS3008 – Wiring Rules.
5. AS 4254 - Ductwork for air handling systems in buildings.
6. AS 1432 - Copper tubes for plumbing, gas fitting and drainage applications.
7. Building Code of Australia
8. All other relevant Australian Standards
9. Any Authority Requirement having jurisdiction on the project including the DA conditions and the fire brigade
10. Acoustic Report
11. Fire Engineering Report

10.3 INTERNAL AND EXTERNAL DESIGN TEMPERATURES

10.3.1 EXTERNAL DESIGN CONDITIONS

For cooling and heating load calculations, the external conditions listed below shall be used:

- Summer Ambient Conditions: DB 29.6^{o}C, WB 22.6^{o}C
- Winter Ambient Conditions: 5.0^{o}C
- Climate Zone 5
- Building Fabric Details as Per The Project Section J Report.

10.3.2 INTERNAL DESIGN CONDITIONS

For cooling and heating load calculations, the internal conditions and heating loads listed below shall be used:

Room	Occupancy (m^2 /person)	Internal Design Temp (Cooling Mode °C)	Min. Outside Air (l/s/person)	Exhaust Air (L/s)	Lighting and Small Power (W/m^2)
Office Spaces / Meeting Rooms	As per Furniture Layouts	23 ± 1.0°C	10 L/s/person	N/A	27
Gym	As per Furniture Layouts	23 ± 1.0°C	10 L/s/person	NA	27
Kitchen Dining	As per Furniture Layouts	23 ± 1.0°C	10 L/s/person	Sized to suit a domestic rangehood.	27
Medical Store	As per Furniture Layouts	23 ± 1.0°C	10 L/s/person	N/A	27
Ambulance Plant	As per Furniture Layouts	23 ± 1.0°C	Natural ventilation through fixed open louvres	N/A	N/A
Comms Room	N/A	23 ± 1.0°C	N/A	N/A	To suit proposed equipment. Provisionally 1500w per rack.
Toilet / Amenities	N/A	N/A	N/A	10l/s.m² or 25l/s per fixture (whichever is greater)	N/A
Cleaner Room	N/A	N/A	N/A	5 l/s/m2	N/A
Lockers	As per Furniture Layouts	23 ± 1.0°C	10 L/s/person	5 l/s/m2	27

10.4 NOISE LEVELS

Noise levels within the spaces for all new systems and modifications to existing systems shall be in compliance with the project specific acoustic report and client brief. In the

absence of an acoustic report and a client specific brief, use table listed below as follows (areas not specifically listed below shall be designed in compliance with AS2107):

Open plan offices	40dBA
Private offices	35dBA
Meeting and Conference Rooms	30dBA
Equipment/computer rooms	45dBA
Staff break areas	45dBA
Toilet areas	50dBA

10.5 DESIGN LOAD CALCULATIONS

Design load calculations shall be performed using Hourly Analysis Program (HAP-Carrier Corporation) software, or equal approved.

10.6 SIZING OF DUCTWORK

Galvanised steel air conditioning and ventilation ductwork shall be sized within the following parameters:

Pressure drop: 0.8 Pa/m Max.

Maximum Duct Velocity: 5m/s inside apartments; elsewhere (including commercial buildings) as follows:

Maximum Duct Velocity:	up to 5,000 l/s	5 to 6 m/s (subject to 0.8 Pa/m and any acoustic report requirements)
	5,000 l/s to 8,000 l/s	8 m/s (subject to 0.8 Pa/m and any acoustic report requirements)
	over 8,000 l/s	10 m/s (subject to 0.8 Pa/m and any acoustic report requirements)
	Return air transfer duct	1.5 m/s to 2 m/s

Flexible Ductwork shall be sized as follows:

Flexible Duct Diameter (mm)	Air Flow Rates (l/s)
150	1 to 45
200	46 to 90
250	101 to 125
300	126 to 175
350	176 to 200
400	201 to 300
450	301 to 400

10.7 EQUIPMENT SIZING

10.7.1 GENERAL

Allow a maximum of 5% safety factor in all calculations.

10.7.2 FANS

Size all fans to deliver 10% more air than required by the design against the resulting increased system resistance.

Fans motors shall be selected such that the fans are capable of delivering 10% additional air in each system at the resulting increased system resistance, without increase in motor size.

10.9.1 AIR FILTERS

Filters shall be adequately selected and sized to suit manufacturer recommendations and equipment selection as to allow equipment selection compliance with the NCC Section J requirements.

10.7.3 DOOR GRILLES

Undercuts shall be sized properly and are only acceptable for air flow rates less than 50 l/s.

Where door grilles are to be provided in lieu of door undercuts or transfer ducts, they shall be sized as follows:

Air Flow (l/s)	**Size (m2)**
0 to 150	0.15
151 to 200	0.18
201 to 300	0.28
301 to 500	0.45
501 to 600	0.55

MECHANICAL SERVICES - TENDER PRICE BREAK UP

Prices for all items listed are to be filled in this schedule by the tenderer and lodged with his tender. The prices shall include all sub-contractor's cost, including overhead and profit. The cost of any material or service to be provided free of charge to the mechanical sub-contractor by the builder shall be clearly identified in this schedule.

The builder reserves the right to reject any tender if the prices submitted are considered unreasonable.

Item No.	Description	Price
1	VRV air conditioning Heat Recovery System	$
2	Air conditioning ductwork including insulation and acoustic lining.	$
3	Comms Room air conditioning	$
4	Outdoor intake systems including fans, ductwork, acoustic lining/attenuators and grilles	$
5	Ventilation systems including, fans, ductwork, internal insulation.	$
6	Roof Mounted Ventilators	$
7	Fire Damper(s)	$
8	Electrical switchboards and cabling	$
9	Control systems	$
10	Miscellaneous items including plinths, painting, pipe sleeves.	$
11	Shop drawings and working drawings.	$
12	Testing and Commissioning.	$
13	Maintenance during defects liability period.	$
14	"As Built" drawing, O&M manuals	$
	TOTAL TENDER PRICE	**$**

This schedule is part of our tender and the sub-contract.

Tenderer: ……

Name: ……

Date: ……

MECHANICAL SERVICES – TECHNICAL DATA

A copy of this Schedule is to be completed by the Tenderer and lodged with his Tender.

Item No.	Description	Data
1	**VRV Air Conditioning Units** Provide the following information: Manufacturer Model No. Refrigerant	
2	**Filters** Manufacturer	
3	**Roof Mounted Ventilators** Manufacturer	
4	**Fans** Manufacturer	
5	**Grilles** Manufacturer	
6	**Controls**	
7	**Electrical Subcontractor**	
8	**Sheet Metal sub-contractor**	

This schedule is part of our tender and the sub-contract.

Tenderer:……

Name:……

Date:…….....

MECHANICAL SERVICES – SCHEDULE OF UNIT RATES

Prices for all items listed are to be filled in this schedule by the tenderer and lodged with his tender. The prices shall include all sub-contractor's cost, including overhead, profit, site allowance and preliminaries. The prices shall also include for any costs to be associated with mechanical contractors' responsibilities to include such additional items within the shop drawings and as built drawings.

The builder reserves the right to reject any tendered prices submitted.

Item No.	Description	Rate
1	Supply and installation of 600 x 600 square diffuser, associated supply air plenum box, 6m of flexible ductwork and connecting the diffuser.	
2	Installed cost per square metre of ductwork. Sheetmetal thickness mm: 0.6 0.8 1.0 1.2	
3	Installed cost per square metre of 50mm internal insulation.	
4	Installed cost per square metre of 75mm internal insulation.	
5	6m flexible duct with minimum R1 acoustic insulation: 150 ∅ 200 ∅ 250 ∅ 300 ∅	
6	Motorised smoke/fire dampers:	
	300 x 250	
7	Supply and install volume control dampers (VCD):	
	250 x 250	
	300 x 300	
8	Ceiling mounted RA eggcrate grille c/w insulated return air plenum 600 x 600	
9	New wall mounted thermostat and wiring	
10	Installed roof mounted ventilator	
11	Hourly rate for Testing and Commissioning Technicians	
12	Hourly rate for air duct and pipe workers	

This schedule is part of our tender and the sub-contract.

Tenderer: ……

Name: ……

Date: ……

ENGINEERING SPECIFICATION FOR ACOUSTIC SERVICES

RAIR FAIRY MEADOW

ISSUE	COMMENT	DATE	PREPARED BY	JOB NO.
P1	DRAFT ISSUE FOR INFORMATION	08/08/2022	D HUNTER	210067
A	ISSUE FOR CONSTRUCTION	29/09/2022	D HUNTER	210067

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DOCUMENT CONTROL SHEET

Project Number	210067
Project Name	RAIR Fairy Meadow
Description	Acoustic Specification – Issue for Construction
Key Contact	Joelle Jello

Prepared By

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Revision History

Issued To	Revision and Date						
MACE	REV	P1	A				
	DATE	08/08/2022	29/09/2022				
DJRD	REV	P1	A				
	DATE	08/08/2022	29/09/2022				
	REV						
	DATE						
	REV						
	DATE						

CONTENTS

1 INTRODUCTION

1.1 CONDITION OF CONTRACT – GENERAL

Refer to the contract preliminaries prepared by the Client's representative for general condition of tendering and contract.

1.2 PROJECT AND BUILDING DESCRIPTION

The proposed development site is located in the north-western section of 7 Squires Way, Fairy Meadow– legally known as Lot 1/DP1172135 being located within a special activities area within the Innovation Campus of Wollongong University.

The site is surrounded by residential and educational buildings, recreational areas and large open conservation spaces in a suburban residential environment with continuous traffic flows along Squires Way during peak periods. The proposed development will operate 24 hours per day, 7 days per week.

The proposed development involves the construction of an Ambulance Station comprising:

- 8 ambulance bays.
- Staff Carpark.
- Internal ambulance wash bay.
- Administration area with private offices and a Meeting room.
- Amenities and common areas.
- Sleeping pods.
- Gym.
- Logistic and services areas.

The project architects are DJRD, the Mechanical, Electrical and Hydraulic Services Engineering services are provided by JHA Consulting Engineers. JHA Consulting Engineers has been engaged to provide acoustic services for this project.

1.3 SCOPE OF SPECIFICATION

This acoustic specification outlines the acoustic requirements and installation quality controls applicable for the following:

- Internal Walls and Doors, to control noise transfer between internal areas.
- Building envelope to control noise break-in.
- Acoustic Finishes, to meet the required room acoustic performance and reverberation times for internal areas.
- Building Services, to control noise transfer from building services to internal areas, plus to control noise transfer from mechanical services to external areas and close properties / receivers.
- To comply with Green Star requirements as per ESD Design Guidelines prepared by WSP – dated 07/09/2021.

This document shall be read in conjunction with all other Contract Documents including the architectural drawings, specification and schedules by DJRD; the mechanical services drawings, specification and schedules by JHA Engineers, the hydraulics drawings, specification and schedules by JHA Engineers, plus electrical drawings, specification and schedules by JHA Engineers.

This document and related work have been prepared following JHA Consulting Engineers Quality and Environmental Management Systems, which are based on AS/NZS ISO 9001:2015 and ISO 14001:2015.

1.4 WORKS BY OTHERS

The main Contractor is responsible for ensuring that all of the acoustic performance requirements specified, noise and vibration criteria in this document are satisfied. Notwithstanding the acoustic performance requirements given in this specification, the Contractor must ensure full compliance with this specification with respect to construction materials, installation and workmanship.

Any deficiencies in performance shall be rectified by the Contractor in accordance with this specification document. All costs associated with rectification works are assumed by the Contractor, and rectification work shall not conclude until the specification is satisfied.

All works completed shall be in accordance with the current Australian Standards, NSW Health Infrastructure Engineering Services Guidelines, Building Code of Australia and the Development Consent Conditions.

1.5 RESPONSABILITIES

This specification is intended to represent the nature of the works to be undertaken. The Contractor is responsible for the provision of all aspects of the acoustic services in order to provide architectural elements plus noise and vibration control measures for the building services which meet the requirements established in Section 2 in accordance with the NSW Health Infrastructure Engineering Services Guidelines.

Where the Contractor provides design (alternative solutions), this shall be carried out by a suitably qualified Acoustic Engineer, being a member of either the AAAC or AAS. Proposed design shall be accompanied by technical specification and supporting evidence of their acoustic performance complies with the documented acoustic design.

2 PROJECT CRITERIA

2.1 EXTERNAL NOISE EMISSIONS

Noise from building services and other operational noise sources to other nearby noise sensitive receivers shall be controlled to comply with noise limits.

These noise limits are in accordance with the *Acoustic Report for REF /DA*[1] prepared by JHA Engineers, derived from NSW EPA Noise Policy for Industry. These values shall be met at the boundary of the nearest sensitive receivers.

Indicative Noise Amenity Area	*Period*	*Project Noise Trigger Levels, $L_{Aeq,15min}$*
General Residential (R1)	Day	51
	Evening	43
	Night	38
School Classroom (External)	Nosiest 1-hour when in use	43
Active Recreation	When in use	53

Table 1: Project Noise Trigger Levels.

2.2 INTERNAL NOISE LEVELS

2.2.1 ENVIRONMENTAL NOISE INTRUSION

All elements of the building façade will need to be constructed to control external noise entering the building. Sound insulation performance requirements for each element should be nominated based on external noise levels from all noise sources that surround the building.

External elements including, glazing, doors and ventilation openings are generally the weakest elements in an external façade and therefore careful consideration is required in the design and specification to ensure that sufficient sound insulation is provided by the combined performance of a façade.

Environmental noise intrusion should be considered in aggregate with the noise from mechanical services to satisfy the maximum noise levels in Column "A" of Table 2 in Section 2.5.

2.2.2 STEADY STATE / CONTINUOUS NOISE

When assessing environmental noise intrusion from relatively continuous noise sources, such as free flowing road traffic, the facade should be designed to achieve the maximum allowable internal noise levels as given in Column "A" of Table 2 in Section 2.5.

The environmental noise intrusion should be considered in aggregate with the noise from mechanical services to satisfy the maximum noise levels in Column "A" of Table 2 in Section 2.5.

[1] Acoustic Report for DA/REF. RAIR Fairy Meadow. JHA Engineers. Ref: 210240 AC-DA-FAI2[A] dated 06/07/2022.

2.2.3 RAIN NOISE

The roof and ceiling construction will be designed so that rain on roofing (particularly metal roofing) does not significantly raise the noise level within internal spaces.

The design will achieve and internal noise level (from rain noise) equal to Column "A" of Table 2 in Section 2.5 plus 10dB based on the estimated maximum rainfall intensity for a 1-hour duration in a year, as given by the Bureau of Meteorology for that location.

2.2.4 BUILDING SERVICES

The internal noise levels due to mechanical plant should be designed to meet the internal noise criteria as per Column "A" of Table 2 in Section 2.5 in aggregate with other sources of continuous noise.

The internal noise levels are to be free of tonality and should not include annoying characteristics including tones and distinctive low or high frequency components described as rumbly or hissy. Nor should the noise contain amplitude or frequency modulation components referred to as humming or beating.

The maximum noise level from mechanical services should be considered in aggregate with the environmental noise intrusion to satisfy the maximum noise levels in Column "A" of Table 2 in Section 2.5.

2.3 REVERBERATION TIMES

The room reverberation time (RT) is the most reliable descriptor of room acoustic performance although good room acoustics is not solely dependent on RT. The reverberation times in the spaces must be controlled to satisfy the times given in Column "E" of Table 2 in Section 2.5.

The reverberation times are given as RT_{mid} (arithmetic average of the reverberation times of the octave bands at 500Hz and 1,000Hz), in seconds.

2.4 SOUND INSULATION PERFORMANCE

In summary, designing the sound isolation rating of the partition must consider:

- Adjacency of any noise generating spaces (e.g., plant rooms) to noise sensitive rooms and achieving internal noise levels as per the requirements of Column "A" of Table 2 in Section 2.5;
- Speech privacy requirements as per Column "A" of Table 3 in Section 2.5;
- Column "B" of Table 3 in Section 2.5 indicates which room types typically require an acoustic door.
- The reduction in achieved performance from laboratory to the field (flanking paths etc.);
- The composite sound isolation performance of the partition (i.e., reductions in performance resulting from weaknesses in the partition including, doors, glazing, ceilings etc.); and,
- The background noise level within the receiver room.

The relief rooms (sleep pods) within the Ambulance Station are categorised as Class 3 as per the NCC; therefore, part F5 of the NCC applies and the following are the minimum acoustic requirements to be achieved:

- Walls shall have an airborne $R_W + C_{tr}$ not less than 50 between SOUs.
- Walls shall have an airborne R_W not less than 50 between SOUs and parts of different classification.
- Entry door via corridor shall have an airborne R_W not less than 30.

2.5 SUMMARY OF ESG ACOUSTIC REQUIREMENTS

A summary of the general acoustic requirements described above as per NSW Health Infrastructure ESG is shown in Table 2, whilst a summary of speech privacy requirements is shown in Table 3.

ACOUSTIC REQUIREMENTS FOR AREAS AFFECTING PATIENT CARE HOSPITALS AND OUTPATIENT FACILITIES							
AREA DESIGNATION	*A*		*B*	*C*	*D*	*E*	*F*
	Continuous Internal Noise Levels, L_{Aeq} dB		*Intermittent Internal Noise Level, L_{Amax} dB (9)*	*Internal Noise Level Helicopter, $L_{Amax,s}$ dB (7)*	*Impact Sound Insulation, $L_{n,w}$ dB*	*Reverberation Time (fully furnished), sec*	*Emergency Generator Internal Noise Level, L_{Amax} dB (11)*
	Satisfactory	*Maximum*					
STAFF / BACK-OF-HOUSE AREAS							
Private Office	35	40	---	70	55	0.6 – 0.8	+5
Multi Person Office	40	45	---	75	55	0.4 – 0.6	+5
Meeting Room	35	40	---	70	55	0.6 – 0.8	+5
Locker Room	50	55	75	---	---	---	+10
Rest Room	40	45	---	75	---	0.4 – 0.6 (8)	+5
Plant Rooms	N/A	< 85	---	---	---	Minimise	---

Table 2: General Acoustic Requirements.

Notes:

1. All sound pressure levels referenced to 20 micro-Pascals (dB re 20μPa).
2. For Column "A", L_{eq} noise levels should be measured over a repeatable, worst-case one hour period. A one hour averaging period has been selected to best represent impacts from continuous noise sources, and any frequently occurring intermittent noise sources.
3. The repeatable maximum noise level generated by lift operations should not exceed the maximum L_{eq} noise level specified for that space (excluding lift lobbies).
4. Reverberation times are the spatial average in fully furnished rooms, generally for full octave bands with centre frequencies of 500Hz and 1kHz.
5. Ambient noise levels to be in the range between "Satisfactory" and "Maximum" in Column A where the rooms have a "Confidential" or "Private" Speech Privacy Requirement. In other words, the "Satisfactory" criterion should be interpreted as a "minimum" value for rooms that require a degree of acoustic privacy, unless partition ratings have been otherwise determined using lower background noise levels. In this case the design basis should be nominated.
6. Speech and Language Therapy excludes audiometric rooms and specialist test and measurement rooms that require more controlled ambient noise conditions.
7. Noise levels apply to Westmead and Royal North Shore Hospitals. Also, for new buildings with a rooftop helipad, specific consideration should be given to controlling helicopter noise levels, in agreement with NSW HI on a case-by-case basis. In addition, direction should be sought from NSW HI on a project-by-project basis as to whether consideration should be given to "future-proofing" the building against future increases to helicopter movements.
8. Where practical.

9. The acceptability of any intrusive noise depends on the frequency of occurrence, the intrusive noise level and character, plus the sensitivity of the space. The intermittent internal noise levels shown are intended to apply to any frequently occurring intermittent noise sources including rail, internal and external driveways, loading docks, nearby industry, etc. and where the frequency of occurrence of the noise source is sufficiently high or low that adequate control of the intrusive noise level is not achieved via the Column "A", L_{eq} noise levels. The project acoustic engineer is required to apply professional judgement in assessing the frequency of occurrence of the intrusive noise, the intrusive noise level and character, plus the sensitivity of the space in order to apply the intrusive noise limits in Column "B". Justification of the basis of the design needs to be reported for HI review. The intrusive noise limits in Column "B" do not apply to noise from commercial aircraft (which is to be assessed in accordance with AS2021).
10. Where a significant, intermittent and intrusive noise source is prevalent, a sleep disturbance assessment is required. The outcome of this assessment shall be included with the acoustic design.
11. Noise levels are set relative to the 'Maximum' continuous internal noise levels from Column "A".

SPEECH PRIVACY REQUIREMENTS FOR AREAS AFFECTING PATIENT CARE HOSPITALS AND OUTPATIENT FACILITIES				
AREA DESIGNATION	*A*	*B*		
		Door Type [1] / Adjacency		
	Speech Privacy Requirement (For walls with no doors)	*Room to Room*	*Room to Reception / Waiting*	*Room to Corridor*
STAFF / BACK-OF-HOUSE AREAS				
Private Offices	Private	Type 1	Type 1	---
Multi Person Offices	Moderate	---	---	---
Meeting Room	Private	Type 2	Type 1	---
Locker Room	Moderate	---	---	---
Rest Room	---	---	---	---
Plant Rooms	---	---	--- [3]	--- [3]

Table 3: Acoustic Speech Privacy Requirements.

Notes:

1. Door Types
   - Type 1 – Solid core door with perimeter and threshold acoustic seals
   - Type 2 – Specialist acoustic doorset (the use of Type 2 doors should be minimised by appropriate planning)
2. Confidential privacy requirements can be difficult to achieve in practice with cost effective solutions. These spaces should be reviewed and agreed on a case-by-case basis.
3. As required to control noise break-out from plant, equipment or machinery to adjacent areas.

2.6 GREEN STAR DESIGN & AS BUILT V1.3

2.6.1 CREDIT CRITERIA

Based on the ESD Design Guidelines prepared by WSP dated 07/09/2021, two acoustic credit points have been targeted for the project. The proposed acoustic credit points and their criteria/comments are provided in Table 4 below.

Credit No.	*Type*	*Description*	*Comments*
10.1	Internal Noise Levels	1 point is available where internal ambient noise levels in the nominated area are suitable and relevant to the activity type in the room. This includes all sound generated by the building systems and any external noise ingress.	Targeted with no changes to design.
10.2	Reverberation	1 point is available where the nominated area has been built to reduce the persistence of sound to a level suitable to the activities in the space.	Targeted with no changes to design.
10.3	Acoustic Separation	1 point is available where the nominated enclosed spaces have been built to minimise crosstalk between rooms, and between rooms and open areas.	Not targeted.

Table 4: Green Star Acoustic Credit Criteria.

2.6.2 INTERNAL NOISE LEVELS

One (1) point is awarded where project teams demonstrate that internal ambient noise levels in the nominated area are no more than 5dB(A) above the lower figure in the range recommended in Table 1 of AS/NZS 2107:2016. The noise measurement and documentation must be provided by a qualified acoustic consultant and in accordance with AS/NZS 2107:2016. Noise measurement must account for all internal and external noise including noise arising from building services equipment, noise emission from outdoor sources such as traffic, and (where known) noise from industrial process. Occupancy noise is excluded.

Compliance shall be demonstrated through measurement, and the measurements shall be conducted in at least 10% of the spaces in the nominated area. The selection of representative spaces must be justified within the Submission Template and must consider how the spaces are considered to be the most conservative with respect to both internal, and external noise sources.

The range of measurement locations shall be representative of all spaces available within the nominated area. All relevant building systems must be in operation at the time of measurement. Projects less than 500m^2 Gross Floor Area (GFA) must account for measurements conducted in at least 95% of spaces within the nominated area.

2.6.3 REVERBERATION TIME

One (1) point is awarded where the reverberation time in the nominated area is below the maximum stated in the 'Recommended Reverberation Time' provided in Table 1 of AS/NZS 2107:2016. Reverberation refers to the persistent prolonged reflections of sound in a space. A technical definition is provided in AS/NZS 2107:2016. For residential projects, this criterion is 'Not Applicable'. Where note 3 of Table 1 AS/NZS 2107:2016 applies and requires that reverberation times be minimised as far as practical, acoustic absorption should be installed in the noise sensitive space.

Acoustic absorption should be applied in locations appropriate to the function of the space, and located to maximise the acoustic performance of materials selected. The resulting performance of the installed acoustic absorption, irrespective of quantity or location installed, must result in a reverberation time equivalent to or lower than the reverberation time predicted for treating at least 50% of the combined floor and ceiling area with a material having a noise reduction coefficient (NRC) of at least 0.50. Alternatively, compliance may be demonstrated by treating 50% of the combined floor and ceiling area with a material having an NRC of at least 0.50. Dedicated teaching space must have reverberation times in the lower half of the range specified in Table 1 of AS/NZS 2107:2016.

Compliance shall be demonstrated through measurement, and the measurements shall be conducted in at least 10% of the spaces in the nominated area. The selection of representative spaces must be justified within the Submission Template and must consider how the spaces are considered to be the most conservative. The range of measurement locations shall be representative of all spaces available within the nominated area. All relevant buildings systems must be in operation at the time of measurement. Projects less than 500m^2 Gross Floor Area (GFA) must account for measurements conducted in at least 95% of spaces within the nominated area.

3 ARCHITECTURAL ELEMENTS

This Section shall be read in conjunction with architectural drawings, schedules and specifications. Architectural elements shall be built-up as per the architectural drawings and schedules, and shall be located in the positions indicated on the architectural drawings. Other architectural elements not outlined in this Section or without a sound insulation rating are not required to be acoustically rated.

To ensure as far as possible that the required sound insulation performance is achieved on site, the following shall be accommodated during construction and installation.

The sound insulation rating of the architectural elements shall not be less than those indicated in the architectural drawings and schedules. Any alternative material and construction to those outlined in this specification shall be reviewed by the Acoustic Engineer to ensure that the design sound insulation performance is achieved.

The complete constructions, including all construction materials, associated framing and support systems and seals, when tested in accordance with Section 7.2.1, shall provide the minimum weighted airborne sound reduction indexes (R_W) nominated in the architectural documents (where applicable).

The sound insulation ratings are based on laboratory tests. This performance is unlikely to be met on site due to flanking transmissions, construction quality, penetration details and workmanship. To obtain the best sound insulation performance on site, sealing flanking sound transmission paths during installation including but not necessarily limited to junctions between partitions and other building surfaces, air gaps around door-sets, cut-outs for services and the like.

It is therefore the Sub-Contractor's responsibility to ensure that the architectural elements meet the required sound insulation rating. The Contractor shall rectify any deficiencies in performance with respect to the requirements of this specification. The Contractor shall be responsible for all costs associated with the rectification works until the specification is satisfied. Notwithstanding guidance on materials and fixings, the Contractor must ensure full compliance with the Sound Reduction Indices given in the specification.

3.1 BUILDING ENVELOPE

3.1.1 GENERAL

The building envelope (walls, external glazing, ventilation openings and roof) shall be built-up as per the architectural drawings and schedules, and shall be located in the positions indicated on the architectural drawings. To ensure as far as possible that the required sound insulation performance is achieved on site, the following shall be accommodated during construction and installation.

Where acoustic insulation is to replace thermal insulation, it must be adapted to meet the requirements of the thermal insulation specification by, if necessary, introducing additional layers of insulation material and adopting a similar protective outer layer as specified.

Notwithstanding the acoustic ratings given in this specification, the Contractor must ensure full compliance with this specification with respect to construction materials, installation and workmanship.

The Contractor shall rectify any deficiencies in performance with respect to the requirements of this specification. The Contractor shall be responsible for all costs associated with the rectification works until the specification is satisfied. Notwithstanding guidance on materials and fixings, the Contractor must ensure full compliance with the Sound Reduction Indices given in the specification.

Any alternative material and construction to those outlined in this specification shall be reviewed by the Architect and Acoustic Engineer to ensure that the design sound insulation performance is achieved.

3.1.2 DRY WALLS / CLADDING

All dry wall / cladding components in external wall constructions shall meet the following acoustic requirements:

- Metal stud framing or furring channels shall be installed at maximum 600mm centres.
- Where specified, polyester or mineral fibre sound absorptive insulation shall be installed in the wall cavity being inert, incombustible, non-hygroscopic and rot and vermin proof. Unless noted otherwise on the architectural drawings or in this specification, the cavity insulation material shall be 50mm thick with a minimum density of 14kg/m^3.

Based on the information obtained from the architectural drawings, the following tables show the proposed external wall-types and their sound insulation rating (R_W).

ID	*Description*	*R_W (dB)*
5200	Metal cladding / 150mm steel stud with 75mm sound insulation (@8.1kg/m^3)	---
5201	Metal cladding / 150mm steel stud with 75mm sound insulation (@8.1kg/m^3) / 10mm tolerance / 9mm fibre cement (@13.5kg/m^2)	48
5202	Metal cladding / 10mm Foam Thermal Break / Top hat furring / 92mm steel stud with 90mm sound insulation (@9.4kg/m^3) / 13mm impact resistant plasterboard (@10.5kg/m^2)	45
5203	Metal cladding / 10mm Foam Thermal Break / Top hat furring / 92mm steel stud with 90mm sound insulation (@9.4kg/m^3) / 13mm moisture resistant plasterboard (@10.4kg/m^2)	45
5230	Metal cladding / Top hat furring / 190mm blockwork (@1800kg/m^3) / 50mm timber battens with 50mm acoustic insulation (@14kg/m^3) / 13mm impact resistant plasterboard (@ 10.5kg/m^2)	60
5231	Metal cladding / Top hat furring / 190mm blockwork (@1800kg/m^3) / 27mm timber battens / 13mm water resistant plasterboard (@10.4kg/m^2)	50

Table 5: External Wall-types.

3.1.3 EXTERNAL GLAZING

External glazing shall meet a minimum sound reduction performance in order to control noise break-in via the building fabric and shall not exceed the noise levels specified in Section 2.2.

The Contractor shall be fully responsible for ensuring that each glazing specification is satisfied, including the design, construction, and installation of each glazing type.

Any deficiencies in performance, with respect to the requirements of this specification, shall be rectified by the Contractor. The Contractor shall be responsible for all costs associated with the testing and re-testing of the glazing systems until the specification is satisfied.

Notwithstanding guidance on materials and fixings, the Contractor must ensure full compliance with the sound insulation performance given in the specification.

Glazing shall be provided as shown on the architectural drawings and schedules with the nominated type and thickness. Minimum sound insulation performance of the façade – including ventilation openings – shall achieve the internal noise levels established in Section 2.2.

Weighted Sound Insulation Rating (R_W)	*Location*	*Typical arrangement*	*Type*
32	General Glazing	Single	6.38mm laminated
37	Male WC and Lockers W-04, W-05	Single	12.38mm laminated

Table 6: External glazing.

The Contractor shall be fully responsible for ensuring that each glazing specification is satisfied, including the design, construction, and installation of each glazing type.

All framing and ancillary elements shall perform similarly such that the whole assembly when completed and in position. The construction of all glazing, framing, ironmongery, seals, surrounds, packing and fixings shall be such as to maintain the full performance of the sealed units.

Seals shall be formed from materials capable of maintaining their elastic qualities and dimensions, and shall be resistant to physical or chemical attack, sufficient to maintain the full acoustic performance of the glazing system during its design life.

The Contractor shall be responsible for ensuring that the glazing framework is effectively sealed to the building structure to achieve the acoustic performance requirements. Any variations in materials and / or constructions used shall only be accepted if approved by the Acoustic Engineer and Architect.

The Contractor shall be responsible for ensuring that the installation tolerances and gaps specified are maintained at all times, and never exceeded. The completed installations shall be capable of accommodating the specified building tolerances and expected building movement without reduction in the specified maximum gaps and tolerances.

3.2 INTERNAL NOISE CONTROLS

3.2.1 WALLS AND PARTITIONS

3.2.1.1 Construction

Full-height / slab-to-slab partitions are used for all partitions rated R_W40 or above.

For blockwork and brickwork, all joints must be filled solid with mortar to the full depth of the wall and services must not be chased into concrete or masonry elements. Mechanical connection between masonry / concrete leaves shall be avoided.

Plasterboard / dry wall constructions shall be installed with the fixings, joint seals and other ancillary material in accordance with the manufacturer instructions. Joints between plasterboard layers and between a plaster and slab shall be acoustically sealed.

If one layer is required on both sides of a wall, it must be fastened to the studs with joints staggered on opposite sides; and if two layers are required, the second layer must be fastened over the first layer so that the joints do not coincide with those of the first layer; and joints between sheets or between sheets and any adjoining construction must be taped and filled solid.

Edge joints to masonry wall or columns shall be close fitting, with a gap of maximum width 10mm. The gaps shall be filled with non-hardening mastic or sealant.

Metal stud framing or furring channels shall be installed at minimum 600mm centres. Head and foot channels shall be mechanical fixed to the ceiling slab and floor slab, and be fully sealed with a bead of non-hardening mastic or sealant between the channel and the slab. In partitions with blockwork, a 10mm minimum gap shall be between blockwork and steel studs.

The thickness and density of the sound insulation within the cavity shall be as per Acoustic Engineer documentation. Sound absorptive material shall be inert, incombustible, non-hygroscopic plus rot and vermin proof. Insulation installed into partition cavities shall be installed so voids are not present due to settling and shall fill all partition cavity.

The perimeter of the timber or metal stud framing members must be securely fixed to the adjoining structure, bedded in resilient compound; and joints must be caulked so that there are no voids between the framing members and the adjoining structure.

Following figure shows the recommended wall / partition junction detail to minimise flanking path noise transmission and maintain the sound insulation performance of wall / partitions achieving a sound insulation rating $R_W \geq 50$.

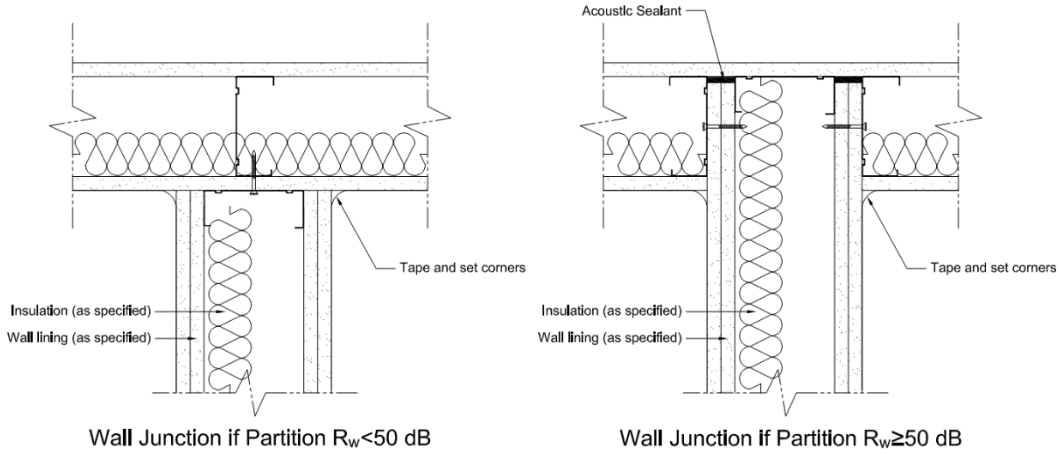


Figure 1: Wall / partition junction detail to minimise flanking path via walls.

Glazed partitions and glazing shall be provided in the locations as shown on the Architect's drawings. All framing and ancillary elements shall not reduce the sound insulation performance of the partition when completed and installed. If there is not laboratory sound insulation test evidence for the whole assembly, aluminium framing shall be packed with medium density glasswool / rockwool (45-48kg/m^3) and compressed to 80%.

Based on the information obtained from the architectural drawings, Table 7 shows the nominated wall-types and their sound insulation rating (R_W). This information has been retrieved from the architectural drawings.

ID	Description	R_W (dB)
5220	13mm impactcheck plasterboard (@10.5kg/m^2) / 92mm steel stud with 60mm sound insulation (@ 26kg/m^3) / 13mm impactcheck plasterboard (@10.5kg/m^2)	45
5221	9mm fibre cement (@ 13.5kg/m^2) / 150mm steel stud with 60mm sound insulation (@26kg/m^3) / 13mm gyprock ECO8 plasterboard (@12.1kg/m^2)	50
5222	13mm impactcheck EC08 plasterboard (@12.1kg/m^2) / 92mm steel stud with 88mm sound insulation (@26kg/m^3) / 13mm moisture resistant plasterboard (@10.4kg/m^2)	47
5223	13mm moisture resistant plasterboard (@10.4kg/m^2) / 92mm steel stud with 88mm sound screen insulation (@26kg/m^3) / 13mm moisture resistant plasterboard (@10.4kg/m^2)	46
5224	9mm fibre cement (@13.5kg/m^2) / 92mm steel stud / 9mm fibre cement (@13.5kg/m^2)	45
5224b	9mm fibre cement (@13.5kg/m^2) / 92mm steel stud with 75mm sound screen insulation (@32kg/m^3) / 9mm fibre cement (@13.5kg/m^2)	50
5225	9mm fibre cement (@13.5kg/m^2) 150mm steel stud with 60mm sound insulation (@26kg/m^3)/ 13mm moisture resistant plasterboard (@10.4kg/m^2)	50
5232	13mm impactcheck plasterboard (@10.5kg/m^2) / 27mm timber battens / 190mm blockwork (@1,800kg/m^3) / 27mm timber battens / 13mm moisture resistant plasterboard (@10.4kg/m^2)	50
5233	13mm impactcheck plasterboard (@10.5kg/m^2) / 27mm timber battens / 190mm blockwork (@1,800kg/m^3) / 27mm timber battens / 13mm impactcheck plasterboard (@10.5kg/m^2)	50
5255	13mm impactcheck plasterboard (@10.5kg/m^2) / 27mm timber battens / 190mm blockwork (@1,800kg/m^3) / 50mm timber battens with 50mm acoustic insulation (@14kg/m^3) / 13mm impactcheck plasterboard (@10.5kg/m^2)	50
5256	13mm impactcheck plasterboard (@10.5kg/m^2) / 50mm timber battens with 50mm acoustic insulation (@14kg/m^3) / 190mm blockwork (@1,800kg/m^3) / 50mm timber battens with 50mm acoustic insulation (@14kg/m^3) / 13mm impactcheck plasterboard (@10.5kg/m^2)	$R_W + C_{tr}$ 50

Table 7: Internal Wall-types.

3.2.1.2 Partition and Wall Penetrations

Ductwork and other service penetrations must not reduce the sound insulation performance of partitions. The best principle is to avoid holes being cut through critical separating walls altogether and ensure that all services enter the room via a corridor and do not pass directly from room to room.

Penetrations through acoustically rated partitions ($R_W \geq 50$) shall be sealed with layers of plasterboard on either side. Holes and gaps bigger than 10mm shall be sealed as close as possible with plasterboard. The remaining gap shall be tightly packed with medium / high density mineral wool / polyester and sealed airtight with a non-hardening mastic or sealant. Gaps smaller than 10mm shall be tightly packed with medium / high density mineral wool / polyester and sealed airtight with a non-hardening mastic or sealant.

All ducting and pipework penetrations shall be completely sealed such that the sound insulation and fire performances of the penetrated construction alone is not downgraded.

Where services pass through fire-rated walls or enclosures, the Contractor shall ensure that the penetration sealing detail is fire-rated sufficiently to maintain the fire-rated performance of the wall or enclosure.

Where penetrations are constructed in ceiling structures, the surfaces of the penetration shall be smooth and even (to within 5mm). The penetrations shall not be oversized. If oversized, the penetrations shall be made good to the required size.

Appendix B penetration sketches show design intent only, and are not prepared to a level where they can be relied upon for installation purposes. Where sound insulation rating of any partition is greater or equal than R_W50, critical penetration sketches shall be employed. Installation drawings are required by this Contract for the purpose of installing the services.

Installation should not proceed without installation drawings having been prepared by the responsible Contractor and returned with comments by the Acoustic Engineer.

3.2.2 ACOUSTIC DOORS

3.2.2.1 General

Acoustic Doors shall be provided as shown on the Architect's drawings and schedules (wherever an R_W rating is nominated for a door, or the door is nominated as an acoustic door set) and / or described in the specifications, with the material properties described in this specification. Appendix A shows the location of the acoustic door sets and their sound insulation rating.

Only hinged, solid core timber doors fitted with acoustic door seals should be considered for these doors. For rooms where acoustic doors are required, the following door sets presented in Table 8 are nominated to achieve the proposed acoustic privacy requirements as per ESG.

Acoustic Privacy	*Weighted Sound Reduction (R_W)*	*Composition*	*Acoustic Seals*	
			Frame	*Bottom*
Type 1	R_W30	40-45mm solid core	Raven RP120 / Kilargo IS1212 / Lorient LAS1212	Raven RP99Si / Kilargo IS8020Si / Lorient LAS8006Si
	R_W35	45-50mm solid core Rebated frame	Raven RP120 / Kilargo IS1212 / Lorient LAS1212	Raven RP99Si / Kilargo IS8020Si / Lorient LAS8006Si
Type 2	> R_W40	Proprietary Rebated frame	Proprietary	Proprietary

Table 8: Acoustic door types.

The Contractor shall be fully responsible for ensuring that each Acoustic Door specification is satisfied, including construction materials, installation and workmanship, and the R_W rating shown in the Architect's door schedule.

The Contractor shall rectify any deficiencies in performance with respect to the requirements of this specification. The Contractor shall be responsible for all costs associated with the rectification works until the specification is satisfied.

The door supplier shall be fully responsible for ensuring that each door specification is satisfied, including the design, construction, installation, commissioning and testing of each acoustic door set.

The supplier shall rectify any deficiencies in performance, with respect to the requirements of this specification. The supplier shall be responsible for all costs associated with the testing and re-testing of the doors until the specification is satisfied.

Notwithstanding the guidance on materials and fixings, the Contractor must ensure full compliance with the R_W ratings given in the door schedules and specification.

All acoustic door leaves shall be solid (not hollow construction) and composite door leaves shall not be used without Acoustic Engineer approval. There shall be no open key holes or a transfer grille in acoustically rated door leaves. Fixing for facing, brackets to hold door open, handles or other items attached to the doors shall not decrease the sound insulation performance.

Where vision panels can be installed in doors, the size of the glazing and performance of the glazing must be such that it has an equal performance to that of the door.

Door frames shall be sealed airtight into the adjoining wall in order to maintain the sound insulation performance.

Where frames are installed in lightweight walls, each layer of the lightweight wall shall be separately sealed to the framing or shall be continued across the door jamb and head to close the wall cavity. Cement or mortar shall be used where frames are installed in masonry walls and gaps shall be filled to the full depth of the wall and shall be installed such that the frame is not wedged.

Framing gaps not exceeding 10mm width may be sealed with non-hardening sealant.

3.2.2.2 Seals

Effective, continuous, acoustic seals shall be provided around the perimeters of all Acoustic Doors, including the threshold. The form and material of the seals shall be such that normal operation of the doors shall not result in seal degradation, loss of acoustic performance or visible uneven sealing lines.

All seals shall be designed to be protected from impacts during operation. Exposed seals shall be protected using steel or other impact resistant material.

Sealing mechanisms shall allow for the accommodation, without loss of acoustic performance, of building tolerances and of floor level variations. The threshold sealing mechanism shall be adjustable to allow for the accommodation of door movement and normal building tolerances without loss of performance. Seals shall not be used to take up tolerances greater than ±30% of the design dimension.

Seals and sealing mechanisms shall be adequately protected against damage during transit and installation. The protection shall remain effective until the doors are commissioned. Seals shall not be stretched. Site cutting of seals shall be limited to an absolute minimum, and shall be approved by the Architect and Acoustic Engineer.

The seals and sealing mechanism shall be guaranteed to maintain the acoustic performance, given fair wear and tear, for a minimum period of 10 years. The design shall allow for simple replacement or adjustment of any elements necessary to restore the acoustic performance to the design value thereafter, at any time during the design life of the Acoustic doorsets as a whole, should any degradation of performance occur after 10 years.

The Contractor shall grout the recesses in the concrete at the door thresholds as necessary, to a minimum density of 2,200kg/m^3. Compression seals shall be fitted to the frames of each Acoustic Door to form continuous seals around the jambs and heads.

Fire seals shall be provided in addition if required as specified by the Architect.

3.2.3 CEILING CONSTRUCTIONS

Edge joints to masonry wall or columns shall be close fitting, with a gap of maximum width 10mm. The gaps shall be filled with non-hardening mastic or sealant.

Metal stud framing or furring channels shall be installed at minimum 600mm centres. Absorbent materials shall be inert, incombustible, non-hygroscopic and rot and vermin proof. Unless noted otherwise on the architectural drawings, all ceiling cavity sound insulation shall be 50mm thick with a minimum density of 14kg/m^3.

Ceilings shall not contact any mechanical or hydraulics services in the ceiling cavity. A minimum clearance of at least 10mm shall be provided between the top of the ceiling lining and the underside of the external dimension of the services.

All ceiling access panels in acoustic rated ceilings are required to be acoustic rated access panels.

Based on the information obtained from the architectural drawings, Table 9: Ceiling types. shows the nominated wall-types and their sound insulation rating (R_W). This information has been retrieved from the architectural drawings.

Ceiling Code	*Construction*
5321	Suspended Smooth Set 10mm standard plasterboard (@ 7.1kg/m^2)
5324	13mm moisture resistant plasterboard (10.4kg/m^2)
5327	Fibre Cement Sheeting 6mm (@ 9kg/m^2)

Table 9: Ceiling types.

3.3 INTERNAL FINISHES

Acoustic wall linings shall be provided in the Meeting room to achieve RT criteria. Minimum required area is 4m^2, assuming 24mm thickness of the acoustic panels with a 50mm air gap (as per manufacturers instructions). The Contractor shall be responsible for constructing the finishes / panels from the materials shown in these documents. Any variations in materials and / or constructions used shall only be accepted if approved by the Acoustic Engineer and Architect.

The acoustic criterion for the acoustic finishes is expressed in terms of the random incidence sound absorption coefficient, as defined in AS ISO 354:2006 *'Acoustics – Measurement of sound absorption in a reverberation room'*. Octave band and one-third octave band values of sound absorption shall be measured directly and provided in the test report.

All acoustic materials including adhesives and surface materials shall be non-combustible and under conditions of fire or intense heat shall not give off toxic emissions. Where required they will comply with all applicable requirements of the current Building Codes.

Nominated sound absorptive treatments applied to walls is Echopanel 24mm with 50mm air gap, or acoustically equivalent. Table 10 shows the sound absorption coefficients for the wall lining.

ID	*Product*	*Sound Absorption Coefficients (α)*						*NRC*
		125	*250*	*500*	*1000*	*2000*	*4000*	
FFE-24410	*Echopanel 24mm with 50mm air gap*	0.15	0.40	0.90	1.00	0.95	0.95	**0.85**

Table 10: Sound absorption coefficients for wall linings.

4 MECHANICAL SERVICES

This section outlines the requirements specific to mechanical services equipment. It is recommended to incorporate these into the mechanical design drawings and specification.

4.1 PLANT ITEMS – GENERAL RECOMMENDATIONS

In order to meet the criteria for internal noise levels and external noise emissions specified in Section 2, low noise building services equipment shall be selected and noise and vibration controls shall be included.

Noise levels generated by all mechanical plant shall be limited to the in-duct and case radiated octave band sound power levels as given in the mechanical documents and schedule in Appendix C. These noise levels are limiting noise levels and, due to the acoustically critical nature of this project, noisier plant items will not be considered.

No measurable tonal sound characteristics shall exist in the tested sound levels. If tonality is considered to be present, the Contractor shall make every effort to eliminate it. Failure to achieve this will require attenuation of the pure tones by the following amounts below the permitted corresponding octave band sound pressure level.

Tonality will be considered to be present if the level of one-third octave band exceeds the level of the adjacent bands on both sides by; 5dB or more if the centre frequency of the band containing the tone is above 400Hz, or 8dB or more if the centre frequency of the band containing the tone is 160Hz to 400Hz inclusive, or 15dB or more if the centre frequency of the band containing the tone is below 160Hz.

Where measures are necessary to control break-out or break-in noise, or as indicated on the drawings, acoustic cladding / wrapping shall be provided for FCUs or fans. Access doors shall be sealed with neoprene gaskets to provide an airtight seal.

In order to prevent vibration from being transferred from the units to the rigid ductwork and building structure, all connections between FCUs or fans and ductwork shall be properly aligned and executed using flexible material (rubberised canvas, lead impregnated PVC or an approved equivalent).

If an alternate mechanical equipment is nominated to replace any plant in this specification, the alternative plant shall have a sound power levels lower than those of the plant that it replaces. The Contractor's mechanical plant selections shall be issued to the Acoustic Engineer and Mechanical Engineer for approval prior to installation.

4.2 PROJECT SPECIFIC NOISE CONTROLS

Install acoustic treatment to the mechanical services in accordance with the mechanical documentation, and including as detailed below, in order to achieve the project specific acoustic requirements:

- Install 50mm internal lining to ductwork as shown on the mechanical services documentation.
- All flexible ductwork is to be internally insulated and shall meet the insertion loss values as stated in this specification. Flexible ductwork shall not pass through full-height walls or walls with vertical ceiling-void barriers.
- Install all mechanical plant with noise levels not exceeding the values for the units as provided in the mechanical services documentation – refer to Appendix C.
- Install vibration isolation to all mechanical services in accordance with the requirements of this specification, the manufacturers and the mechanical services specification.

- Install transfer ducts in accordance with the requirement of this specification – refer to Section 4.4.2. All transfer ducts within acoustically rated partitions be 50mm internally lined.
- Select supply and return diffusers such that the regenerated noise does not contribute to the overall noise level, and such that the resulting noise level in the spaces meets the internal noise requirements.

4.3 FAN COIL UNITS (FCUS) AND FANS

FCUs and fans shall be supported on steel springs and / or neoprene / rubber pads to comply with the requirements of this specification and minimise vibration transmission into the building structure. Access doors shall be sealed with neoprene gaskets to provide an airtight seal.

All connections between FCUs / fans and ductwork shall be properly aligned and executed using flexible material (rubberised canvas, lead impregnated PVC or an approved equivalent).

All pipe and conduit penetrations of FCUs / fan casings shall be acoustically sealed.

All pipes connected to FCUs / fans shall have flexible union pipe connectors. The works Sub-contractor shall ensure that all fan casing/enclosures are adequate to ensure that noise in occupied rooms due to break-out does not exceed the background noise level criteria specified in Section 2 of this specification.

Noise levels generated by FCUs / fans shall be limited to the octave band sound power levels as given in the mechanical schedules. Test data shall be provided to demonstrate conformity with the specified noise levels. Where test data cannot be provided for the actual units to be installed on site, at their operating duties, the Contractor shall provide representative sound level data for approval by Acoustic Engineer.

The Contractor's selections shall be issued to the Acoustic Engineer and Mechanical Engineer for approval prior to installation.

4.4 ACOUSTIC DUCT

4.4.1 INTERNAL LINED DUCTWORK

Sound absorptive duct lining shall be installed internally to air ducts in the locations indicated on the drawings. Ductwork shall be lined internally with 25mm or 50mm thick insulation, as indicated on the mechanical services drawings.

The lining shall be faced with an appropriate material to ensure that the lining shall withstand an air passage velocity of at least 25m/s without surface erosion or other forms of material migration. This facing material shall be a thin, acoustically transparent membrane (such as a woven glass fibre tissue) to provide a tough surface that will present a smooth face to the airstream.

Absorptive materials shall be inert, incombustible, non-hygroscopic, rot and vermin proof and, where required, fire rated.

The duct lining as installed shall have minimum sound absorption coefficients measured according to AS ISO 354:2006 *'Acoustics – Measurement of sound absorption in a reverberation room'*.

Thickness (mm)	Sound Absorption Coefficient							
	63	125	250	500	1k	2k	4k	8k
25	0.05	0.10	0.35	0.55	0.85	0.95	0.95	0.90
50	0.10	0.35	0.55	0.85	0.95	0.95	0.95	0.90

Table 11: Minimum sound absorption coefficient for duct linning.

4.4.2 TRANSFER DUCTS

Transfer ducts shall be located in the positions indicated on the mechanical drawings and above doors – whenever is possible. Transfer ducts shall achieve the performance provided in the Mechanical Engineer documentation plus an insertion loss that minimises reduction of sound insulation performance of the partition where is located.

All transfer ducts shall be at least 50mm thick internally lined – either mineral fibre or polyester with a minimum sound absorption coefficient as per Table 11 – and their construction shall be as follows:

R_W of partition	Ceiling type	Transfer Duct Construction		
		Straight duct length (m)	Maximum airway (mm)	Number of bends
35 – 40	Solid	1.0	200	---
	No solid	1.5	200	1
40 – 45	Solid	1.5	200	---
	No solid	1.5	200	2
45 – 50	Solid	1.0	200	1
	No solid	2.0	200	2

Table 12: Transfer ducts constructions.

The Contractor's selections shall be issued to the Acoustic Engineer and Mechanical Engineer for approval prior to installation.

4.4.3 FLEXIBLE DUCTWORK

All flexible duct shall have acoustically perforated inner sleeve with 10kg/m^3 insulation and shall not be restricted in any way. To minimise re-generated noise, air velocities in flexible ducts shall not exceed the recommended velocities in Table 14.

Flexible ducts shall be connected using standard sheet metal dove-tail or spin-in collars and mechanically attached either with plastic closure straps, metal clamp straps, or approved tape. Connections should be made without bends in excess of 90 degrees – preferable to use radii of at least 1.5 times the flexible duct diameter for bends, using the shortest possible lengths of flexible duct material.

Where the flexible duct is connected to a spigot or collar the inner section of the duct shall overlap with the spigot or collar by at least 100mm. A hose clamp or heavy-duty cable tie with mechanical tensioning shall be used to clamp the flexible duct securely to the spigot. Duct tape shall be used to provide the final seal the insulation and outer sleeve of the flexible duct to the spigot or collar.

Flexible ducts shall be supported at intervals not greater than 1.5m, with maximum permissible sag of 15mm per 300mm of spacing between support points.

Maximum length of flexible ductwork shall be 6 meter in any location, measured from the plenum box to the trunk duct. Flexible ductwork shall not pass through full-height walls or walls with vertical ceiling-void barriers. Where this is unavoidable, a flat, rectangular, internally-lined acoustic transfer duct shall be provided at the wall penetration.

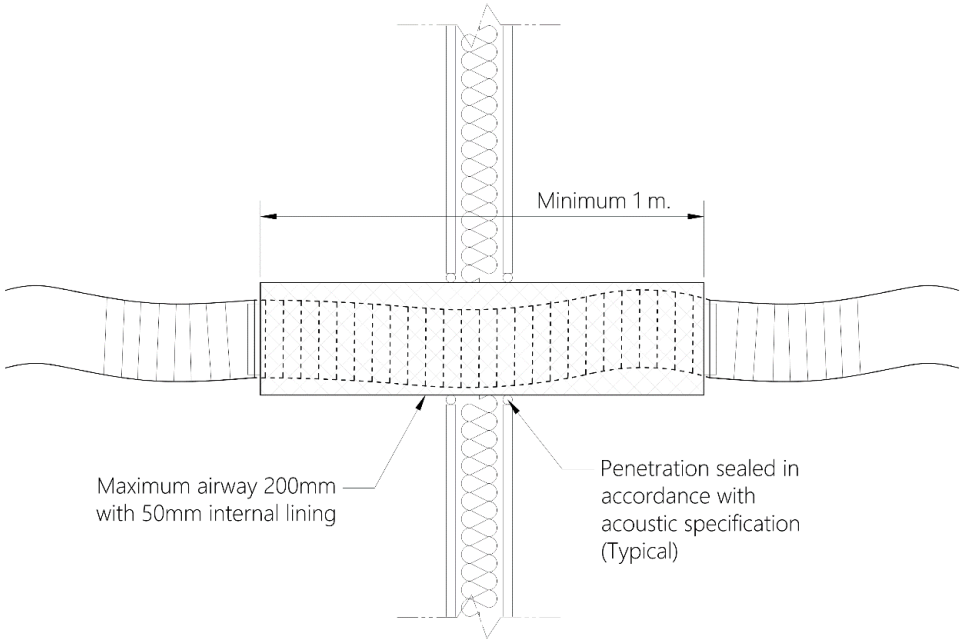


Figure 2: Flexible duct penetration detail.

Where acoustic lagging is required and located on both sides of a flexible ductwork coupling, the coupling shall also be lagged.

The minimum acoustic performance of the flexible ductwork is shown in Table 13.

Diameter (mm)	*Insertion Loss (dB/m)*							
	63	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
150	3	5	7	14	18	20	12	10
200	3	5	8	14	16	17	9	7
250	2	4	8	14	13	14	7	6
300	2	3	7	13	11	12	5	5

Table 13: Acoustic performance specification for flexible ductwork.

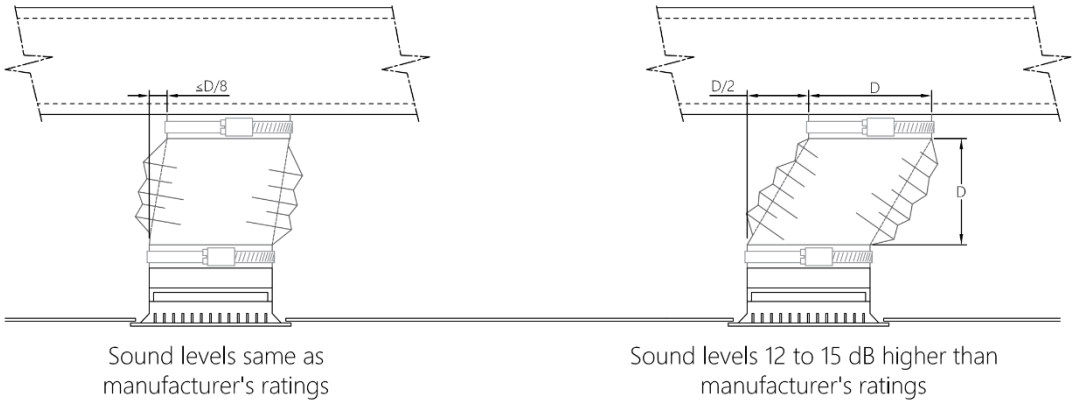


Figure 3: Effect of proper (left) and improper (right) alignment for flexible ductwork connection.

4.4.4 AIR VELOCITIES

Mechanical duct design shall consider the geometry of duct branches, duct tees, transitions for smooth airflow and low duct regenerated noise levels.

To minimise duct turbulence, the separation between different fittings shall be kept to a minimum of three to one duct dimensions. Where this is unavoidable, external stiffeners shall be employed to minimise re-radiated noise due to air turbulences. Internal stiffeners shall not be used.

Table 14 shows the maximum airflow velocities within mechanical ductwork serving internal spaces upon the required noise level criteria.

NR Curve / Noise Criterion dB(A)	*Duct air velocity, in m/s*			
	Main	*Branch*	*Runout*	*Flexible*
20 / 30	4.5	3.5	2.0	1.6
25 / 35	5.0	4.5	2.5	2.0
30 / 39	6.5	5.5	3.2	2.5
35 / 44	7.5	6.0	4.0	3.0
40 / 48	9.0	7.0	5.0	3.5

Table 14: Maximum recommended in-duct airflow velocities.

4.5 AIR TERMINALS / DIFFUSERS / GRILLES

Terminals shall be selected in accordance with the air velocities within the range deemed acceptable by the manufacturer. Notwithstanding with this, terminals shall be quiet in operation and shall not produce tones or hissing noise.

Sound power level data shall be measured in accordance with ISO 5135:1997 *'Acoustics – Determination of sound power levels of noise from air-terminal devices, air-terminal units, dampers and valves by measurement in a reverberation room'*.

The terminals shall be selected to ensure that their self-generated noise together with the noise from the main distribution system do not exceed the noise level criteria specified in Section 2 for the spaces being served.

Terminals shall be selected so that the manufacturer noise level is at least 8 to 10dB lower that the internal noise level criteria for the room it serves.

Ceiling grilles to be located away from transfer ducts. All linear supply air and return slot diffusers shall not be located above a partition line.

Table 15 shows the maximum air velocities for grilles and diffusers serving internal spaces upon the required noise level criteria.

NR Curve / Noise Criterion dB(A)	*Maximum neck velocity, in m/s*		
	Egg-Crate Grille	*Half Chevron Grille*	*Supply Register*
35 / 44	3.0	1.8	2.1
40 / 48	4.0	2.2	2.6
45 / 53	4.5	3.0	3.2
50 / 58	5.5	3.5	3.9

Table 15: Maximum air velocities for grilles and diffusers.

The Contractor's selections shall be issued to the Acoustic Engineer, Mechanical Engineer and Architect for approval prior to installation.

4.6 VIBRATION CONTROL

The Contractor is responsible for the vibration isolation of the mechanical services in order to minimise noise and vibration transmissions to the building structure. Vibration isolation will be required for all mechanical services plant and equipment. Vibration isolation systems are to be selected to meet the noise and vibration criteria set in this specification.

It is the responsibility of Services Contractors, particularly the Mechanical Service Contractor to select appropriate vibration isolation for each plant item. Note, that it may be necessary for the Contractor to engage the services of an appropriately qualified vibration consultant or vibration isolation manufacturer to assist in selection of appropriate vibration isolation.

Where a vibration isolator type is not specified, the type, active material, size and mounting shall be agreed between the machinery and vibration isolator manufacturers and shall comply with this specification.

Vibration isolation components of mechanical systems located in the open air should be weatherproofed, non-rusting and be resistant to or protected from rodent and insect attack by choice of materials and design of components.

Vibration isolation systems for mechanical plant shall be selected accordingly to the weight loads of plant. Vibration isolation shall be incorporated to minimise vibration impacts and shall be sized and selected with the proper deflection. This will allow to no perceptible structural vibration in noise sensitive spaces plus no audible re-radiated noise. The Contractor's selections shall be issued to the Acoustic Engineer and Mechanical Engineer for approval prior to installation.

Generic recommendations for vibration isolation are shown in Table 16 and vibration isolators are to be Embelton, Manson or similar approved by Acoustic Engineer.

Plant Type	*Vibration Isolator Type*	*Minimum Static Deflection (mm)*
In-line Centrifugal Fans	Neoprene mounts or hangers	10
Axial Fans (Ø<450mm)	Neoprene mounts or hangers	10
Axial Fans (Ø>450mm)	Springs or neoprene mounts	25
Fan Coil Units	Waffle pad mounts or neoprene hangers	6
Condenser Units	Waffle pad mounts or rubber mounts	6

Table 16: Vibration isolation recommendations.

In addition to the vibration measures shown above, the following is also recommended to be implemented:

- Statically and dynamically balancing rotating plant and equipment to comply with ISO 21940.11:2016.
- Providing inertia blocks where required.
- Providing flexible connections where ducts and piping are connected to vibrating plant and machinery.

5 HYDRAULIC SERVICES

This section outlines the requirements specific to hydraulic services equipment. It is recommended to incorporate these into the hydraulic design drawings and specification.

Pumps and motor assembly shall be mounted on a concrete filled inertia block and vibration isolated. Pump inertia block shall be designed to support the weight of elbows and other fittings plus the weight of water in the pump and connected pipe work.

Supply and install vibration isolation to all pumps in accordance with manufacturers' data. Provide vibration isolation data to Acoustic Engineer for review and approval.

Piping to vibration-generating equipment must be supported by vibration isolated hangers. Vibration isolation shall be selected to achieve at least 98% efficiency, with at least 10-20mm static deflection.

There must be a minimum of 10mm clearance between any walls, ceilings or risers supporting structure and any hydraulic pipes.

All soil, waste, storm water pipes and downpipes shall be manufactured from PVC material or equivalent, unless where acoustically rated pipes such as REHAU Raupiano Plus or Valsir Silere/Triplus are used as shown on Hydraulic drawings. Where possible, waste pipes shall not be fixed to the walls of the riser shaft but shall be fixed to slab edges.

All storm water pipes shall be externally wrapped with a layer of Pyrotek/Soundlag 4525C, or similar. All downpipes located in the cavity of external walls and internal walls should be installed using appropriate acoustic measures.

Bends within the pipe work should also be gradual as possible, in which sudden 90° angles will create additional unwanted noise.

Hydraulic services must be boxed using 1 layer of 13mm plasterboard and filled with sound insulation. To avoid noise flanking through the services, the gaps around the pipe should be sealed prior to the boxing. This may be done using a fire collar as required by other disciplines.

All access panels shall achieve a minimum acoustic performance of $R_W + C_{tr}$ 25.

Penetrations made through slabs should be sealed for the full depth of the penetration with a cement grout to achieve an airtight seal around the hydraulic services. Reticulation water pipes shall not be chased into sound rated walls.

Supply and install supporting vibration isolation hangers for all hydraulic piping located above noise sensitive spaces with a diameter greater than 40mm.

Water hammer should be eliminated by lowering operating pressures – not exceeding 350kPa – or providing pressure regulators. Fluid velocity should be designed to minimise noise in the pipes and to a maximum approximately of 2.5m/s.

6 ELECTRICAL SERVICES

This section outlines the requirements specific to electrical services equipment, communications and AV cabling for critical spaces. It is recommended to incorporate these into the electrical design drawings and specification.

6.1 IN WALLS

The electrical outlets shall be located with an offset from each other on both sides of the wall not less than 100mm in masonry walls and not less than 300mm in timber or steel frame walls. Electrical outlets include general power and telecommunication outlets, MATV and data outlets, light switches and wall mounted lights.

Acoustic rated fireboxes can be used for acoustic purposes to outlets, particularly when back-to-back electrical outlet can't be avoided. The fireboxes must achieve a minimum sound insulation rating of R_W50.

If acoustic rated fireboxes are not feasible, an acoustic barrier fixed to the metal or timber studs between each electrical outlet shall be located in the cavity – only on one side of the wall.

All electrical penetrations shall be sized for cables and conduits passing through building slabs, plasterboard or masonry walls to allow a uniform clearance of 10mm around the item and this gap shall be sealed using an approved acoustic sealant.

Any alternative sealing details utilised shall be designed to maintain the acoustic rating of the walls, ceilings and floors that they penetrate. Alternative details shall be submitted to the Acoustic Engineer for approval.

Any cable, conduit and the like shall be located within the furring channels wherever it is possible. Services must not be chased into concrete or masonry elements of sound rated walls.

6.2 IN CEILINGS

Cable penetrations through plasterboard ceiling from surface mounted lights, smoke detectors, etc. shall be sealed using an approved acoustic sealant.

A maximum of two penetrations for recessed down lights is permitted in a $5m^2$ ceiling. The maximum diameter of penetrations for down lights don't exceed 95mm and locate down lights penetrations at least 600mm from waste pipes.

If higher concentrations of lights are required or will be in an acoustic rated ceiling, all down lights shall be acoustically treated. Acoustic down light treatment will consist of either down lights purchased with an acoustic can fitted or custom-made galvanised box around the down lights.

7 INSPECTION AND COMMISSIONING

7.1 INSPECTIONS

Should inspection be required by the client, JHA will provide options for periodic inspections of work during construction phase to ensure it complies with the recommendations. This will be at the cost of the Contractor.

The Contractor shall provide documentary evidence to support that the form of construction / material or design being used complies with the performance requirements. Refer to Section 1.4.

The Acoustic Engineer shall carry out inspections of internal walls, floors, ceiling constructions, doors, room finishes and building services during construction.

Sign-off inspections shall be carried out after completion of major acoustic milestones. The Contractor shall identify, in the programme of construction works, dates when each major layer of construction will be completed and made ready for sign-off inspections.

If each major milestone has been inspected and found to be constructed in accordance with the requirements for workmanship and materials specified in the contract documents, it shall be approved by the Acoustic Engineer and the construction of subsequent constructions shall proceed, without on-site compliance testing.

If, in the opinion of the Acoustic Engineer, requirements for workmanship and materials specified in the contract documents have not been satisfied, the Contractor shall carry out all remedial works necessary to satisfy the specification before subsequent constructions proceed.

In particular, the Acoustic Engineer shall check:

- Resilient seals where provided.
- Sufficient air gaps are provided in accordance with architectural drawings.
- No loose materials and debris are left in any air gaps or across resilient connections.
- No cracks or defects are visible in plasterboard layers.

Where wall and ceiling components are separated by an acoustic cavity, effective precautions shall be employed to ensure that cavities and joints remain clear of mortar droppings, broken blocks/bricks or any other debris liable to bridge or close the cavity or joint, for example, using temporary cavity closing boards or sheets.

Any debris entering the cavity as a result of the Contractor's operations shall be removed at the Contractor's expense.

Where penetrations are constructed in walls and ceilings, the surfaces of the penetration shall be smooth and even (to within 5mm). The penetrations shall not be oversized. If oversized, the penetrations shall be made good to the required size.

All measures shall be taken to minimise shrinkage and subsequent cracking in sealants.

7.2 ACOUSTIC TESTING AND COMMISSIONING

Before commencement of commissioning, it shall be submitted a program itemising the systems and the proposed dates for conducting acceptance tests in accordance with the program.

One week prior to the proposed testing date, the Acoustic Engineer shall be notified regarding the testing to carry out and if witnessing is required.

Commissioning procedures and testing methods which are not approved or not in accordance with methods detailed in this specification will not be accepted as evidence that the systems have been correctly commissioned.

The Contractor should demonstrate compliance by acoustic testing according to nominated standards in this document and report results when fully completed prior to handover.

Measurements shall be conducted with Sound Level Meters Type 1, in third octave band frequency ranging from 50Hz to 10kHz and "Fast" time-weighted response.

7.2.1 LABORATORY-TESTED PERFORMANCE

The Contractor shall provide evidence, in the form of laboratory results, to prove that the construction, material selection and design being used complies with the performance requirement outlined by this specification. This will be at the cost to the Contractor.

Compliance with this specification document shall be verified by the laboratory tests and determined in accordance with:

- AS 1191:2002 (R2016) *'Acoustics – Method for laboratory measurement of airborne sound transmission insulation of building elements'*, OR
- ISO 10140.2:2010 (R2016) *'Acoustics – Laboratory measurement of sound insulation of building elements. Measurement of airborne sound insulation'*, OR
- ISO 10140.3:2010 (R2016) *'Acoustics – Laboratory measurement of sound insulation of building elements. Measurement of impact sound insulation'*.

And rated in accordance with:

- AS/NZS ISO 717.1:2004 *'Acoustics – Rating of sound insulation in buildings and of building elements – Airborne sound insulation'*, OR
- AS ISO 717.2:2004 *'Acoustics – Rating of sound insulation in buildings and of building elements – Impact sound insulation'*.

The sound absorption performance of materials will be verified under:

- AS ISO 354:2006 (R2016) *'Acoustics – Measurement of sound absorption in a reverberation room'*, OR
- AS/NZS 1935.1:1998 (R2016) *'Acoustics – Determination of sound absorption coefficient and impedance in impedance tubes – Method using standing wave ratio'*.

Mechanical ducted silencers performance in accordance with:

- ISO 7235:2003 (R2018) *'Acoustics – Laboratory measurement procedures for ducted silencers and air-terminal units – Insertion loss, flow noise and total pressure loss'*.

The Tenderer will provide test reports that show compliance with the acoustic requirements. The reports shall be written in English and as a minimum will contain:

- Results presented in tabular and graphic form over the third octave band centre frequency range from 100Hz to 5000Hz.
- A full written and drawn description giving details of materials, dimensions, thicknesses and weights of the principle components, including seals and furniture (where applicable), together with details of any sealants used at the interface between the frame and test aperture.

Any deviations shall be noted in the test reports. Test certificates shall be obtained from an independent accredited test laboratory approved by the Acoustic Engineer. The test reports shall be submitted to the Acoustic Engineer for approval prior to ordering or construction.

7.2.2 IN-SITU TESTED PERFORMANCE

In-situ acoustic performance testing shall be undertaken by a suitably qualified Acoustic Engineer, being a member of either the AAAC or AAS, on a representative sample of the relevant forms of construction / material or design agreed with the Contractor. The Contractor shall rectify all non-compliances, and the cost of any retesting shall be borne by the Contractor.

Compliance with the performance requirements will be verified when the in-situ-tested performance of the forms of construction / materials comply with the performance requirements in this document when determined under:

- AS/NZS ISO 140.4:2006 *'Acoustics – Measurement of sound insulation in buildings and of building elements, Part 4: Field measurements of airborne sound insulation between rooms'*.
- AS/NZS ISO 140.7:2006 *'Acoustics – Measurement of sound insulation in buildings and of building elements, Part 7: Field measurements of impact sound insulation of floors'*.

And rated in accordance with:

- AS/NZS ISO 717.1:2004 *'Acoustics – Rating of sound insulation in buildings and of building elements - Airborne sound insulation'*.
- AS ISO 717.2:2004 *'Acoustics – Rating of sound insulation in buildings and of building elements – Impact sound insulation'*.

Compliance with the performance requirements for internal noise levels, environmental noise levels and internal room acoustic performance will be verified when the in-situ-tested performances comply with the performance requirements in this document when determined under:

- AS 2107:2016 *'Acoustics – Recommended design sound levels and reverberation times for building interiors'*.
- AS 1055:2018 *'Acoustics – Description and measurement of environmental noise'*.
- AS/NZS 2460:2002 (R2106) *'Acoustics – Measurement of the reverberation time in rooms'* OR
- ISO 3382:2012 *'Acoustics – Measurement of room acoustic parameters'*.

8 EXTENT OF WORKS

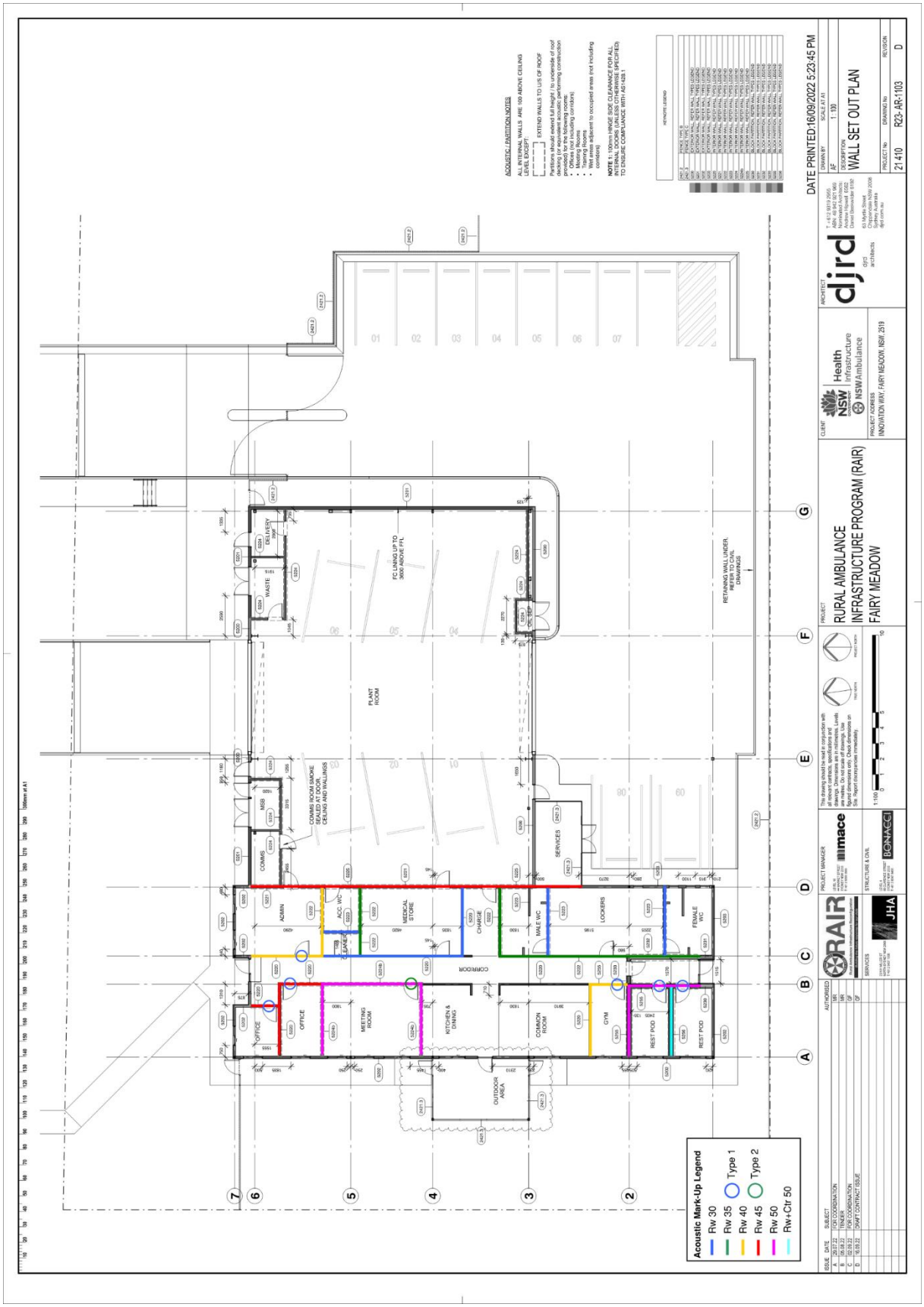
The extent of work covered by this document includes the co-ordination of works by a number of trades affecting the acoustic performance of the completed works.

The following list identifies the work to be undertaken by the Contractor. The listed items are not intended to limit or exclude any items required by the contract documents.

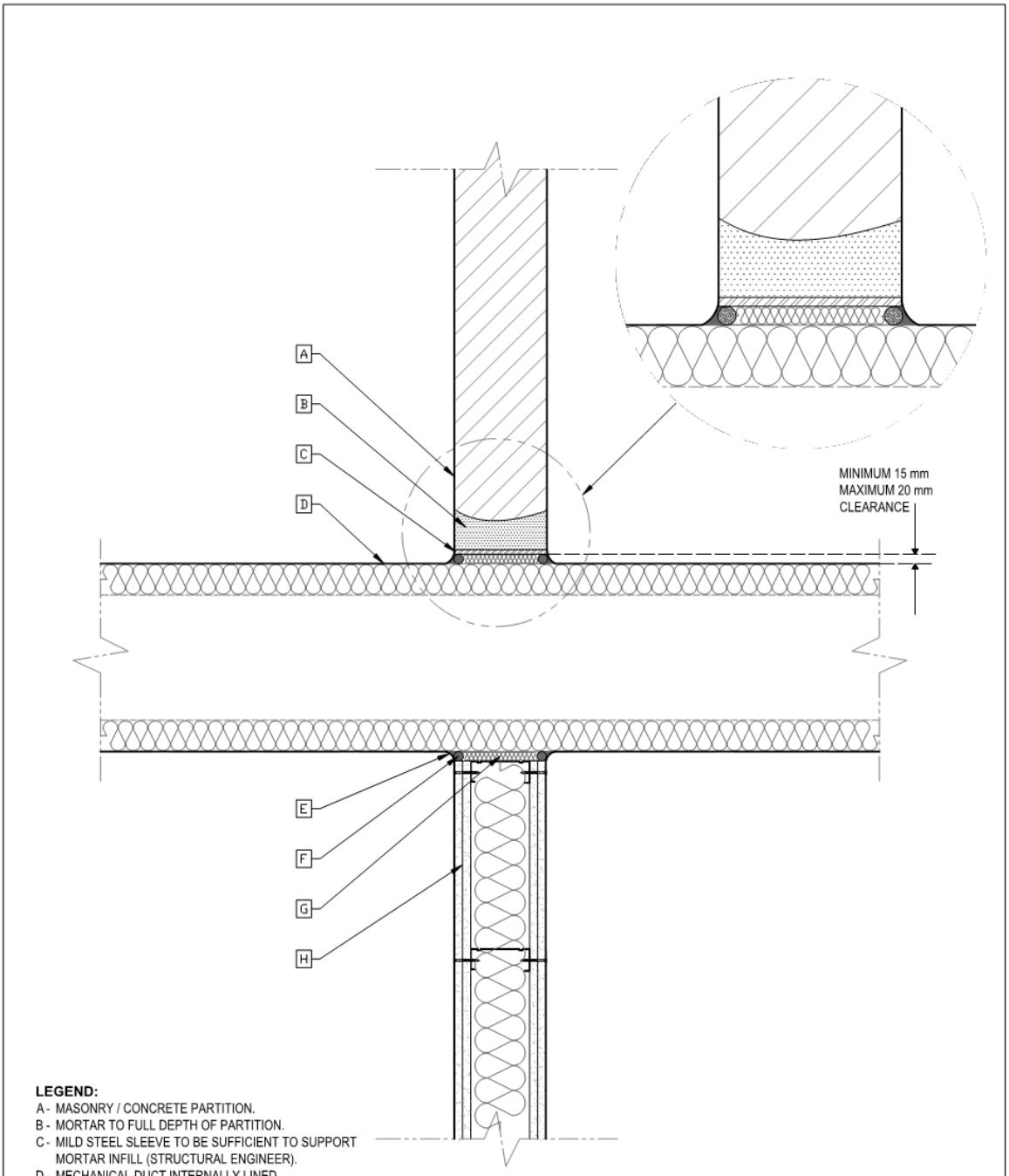
The contract acoustic co-ordination work shall comprise the provision of the following major items:

- Supply and install acoustically rated walls and partitions in accordance with the specifications.
- Acoustically seal all service penetrations passing through full height and sound rated partitions.
- Ensure all thermal or acoustic insulation materials, other than those that are fully enclosed within partition linings, are physically secured so as not to be dislodged during normal use and maintenance of the building.
- Install all partition and ceiling constructions so as to ensure that audible sound leakage through building discontinuities is minimal. In particular, ensure that gaps between a partition head and ceiling system are acoustically sealed. Obtain approval for the proposed seal method before proceeding with the works.
- Seal sound rated partitions at the building façade junction so as to maintain the acoustical performance of the partitions. Obtain approval for the proposed seal method before proceeding with the works.
- Select and install electrical lighting equipment so as the overall acoustic performance of the floor/ceiling system complies with the performance requirements nominated within.
- Select mechanical services equipment so as to comply with the specified background noise levels in areas of occupancy.
- Supply and install acoustic treatment to mechanical equipment as required to comply with specified background noise levels.
- Re-align, and acoustically treat, ductwork where ductwork conflicts with or penetrates through sound rated partitions.
- Externally insulate ductwork, pipe work and equipment as specified and/or shown on the drawings.
- Vibration isolate equipment and systems as required.
- Supply and install acoustic attenuators to mechanical services systems where specified.
- Supply and install acoustically insulated ductwork as shown on the mechanical drawings and as required.
- Supply and install vibration isolation mounts to all mechanical and rotating equipment.
- Provide return air penetrations, to be installed at slab soffit level generally above door locations, where necessary to provide return air relief from enclosed rooms to corridor space.
- Supply and install acoustic wrapping and enclosures to hydraulic services waste pipes where these pipes are located or pass over noise sensitive spaces.
- Commission and test building services systems. This includes the following:
  - Air balancing of all outlets where necessary to conform specified noise levels.
  - Optimise operating duty for air handling plant and equipment.

APPENDIX A: DIAGRAMS SHOWING SOUND INSULATION RATINGS FOR PARTITIONS AND DOORS



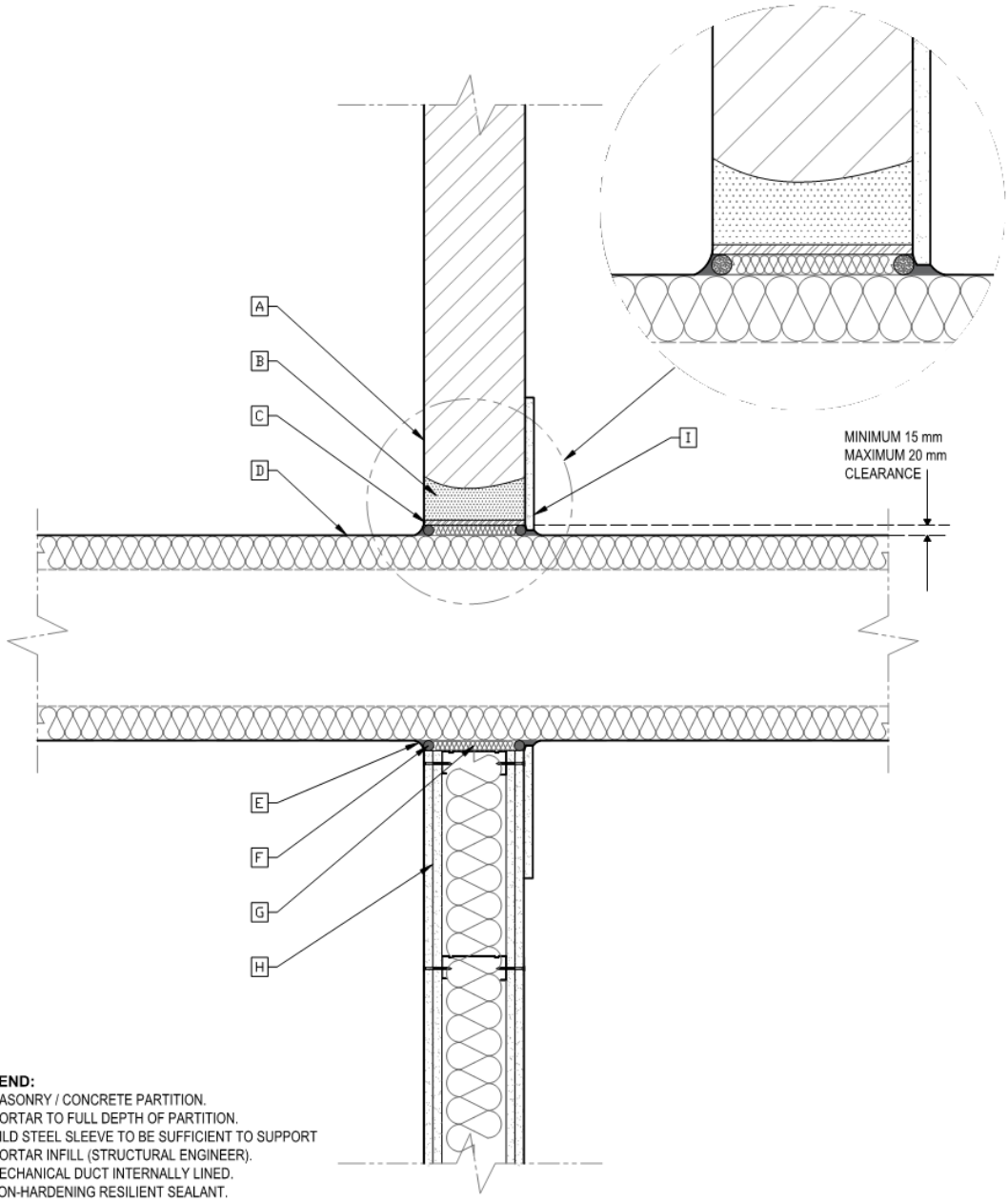
APPENDIX B: TYPICAL DETAILS FOR ACOUSTIC SEALING OF SERVICE PENETRATIONS



LEGEND:

A - MASONRY / CONCRETE PARTITION.
B - MORTAR TO FULL DEPTH OF PARTITION.
C - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
D - MECHANICAL DUCT INTERNALLY LINED.
E - NON-HARDENING RESILIENT SEALANT.
F - COMPRESSIBLE FOAM BACKING ROD.
G - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
H - LIGHTWEIGHT PARTITION.

CONSULTANT	TITLE	DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
JHA Level 23, 101 Miller Street, North Sydney NSW 2060 Australia +61 (02) 9437 1000 general@jhaengineers.com.au www.jhaservices.com	**ACOUSTIC SERVICES** DETAILING FOR INTERNALLY LINED MECHANICAL DUCTWORK - STANDARD SITUATION	D.S.	J.R.	J.R.	N.T.S	08.10.2018
		JOB No. 180035	DRAWING No. AC1101			REV P1



LEGEND:

A - MASONRY / CONCRETE PARTITION.
B - MORTAR TO FULL DEPTH OF PARTITION.
C - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
D - MECHANICAL DUCT INTERNALLY LINED.
E - NON-HARDENING RESILIENT SEALANT.
F - COMPRESSIBLE FOAM BACKING ROD.
G - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
H - LIGHTWEIGHT PARTITION.
I - SOLID BOARD COVER PLATE (MINIMUM SURFACE MASS 10kg/m^2) PLATE BEDDED IN RESILIENT SEALANT.

CONSULTANT

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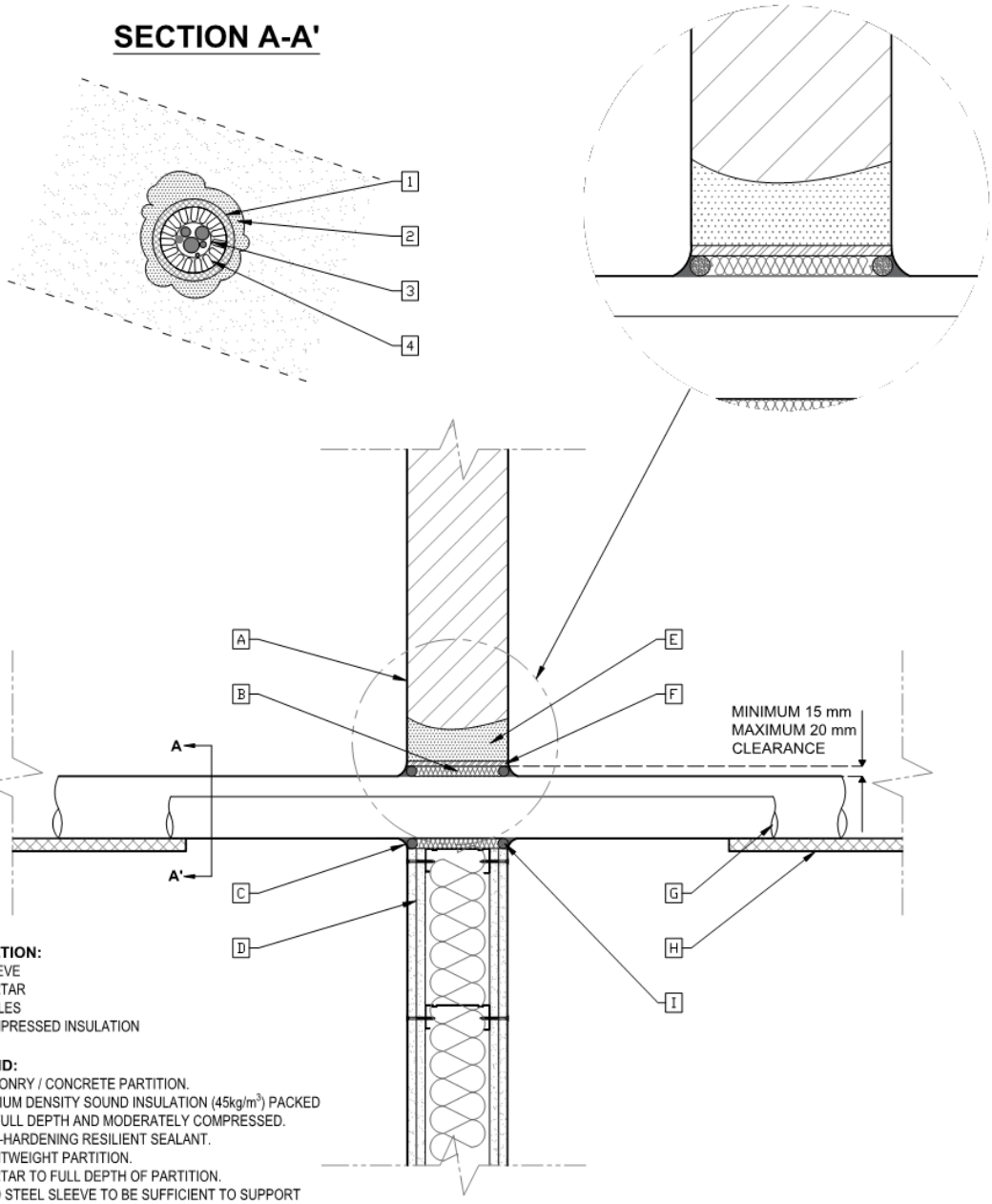
TITLE

ACOUSTIC SERVICES
DETAILING FOR INTERNALLY LINED MECHANICAL DUCTWORK - CRITICAL SITUATION

DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
D.S.	J.R.	J.R.	N.T.S	08.10.2018

JOB No.	DRAWING No.	REV
180035	AC1102	P1

SECTION A-A'



ELEVATION:
1 - SLEEVE
2 - MORTAR
3 - CABLES
4 - COMPRESSED INSULATION

LEGEND:
A - MASONRY / CONCRETE PARTITION.
B - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
C - NON-HARDENING RESILIENT SEALANT.
D - LIGHTWEIGHT PARTITION.
E - MORTAR TO FULL DEPTH OF PARTITION.
F - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
G - LV CABLES.
H - CABLE TRAY INTERRUPTED AT JOINT. EARTH CONTINUITY CONNECTION TO BE SLEEVED WITH OTHER CABLES ON THE TRAY.
I - COMPRESSIBLE FOAM BACKING ROD.

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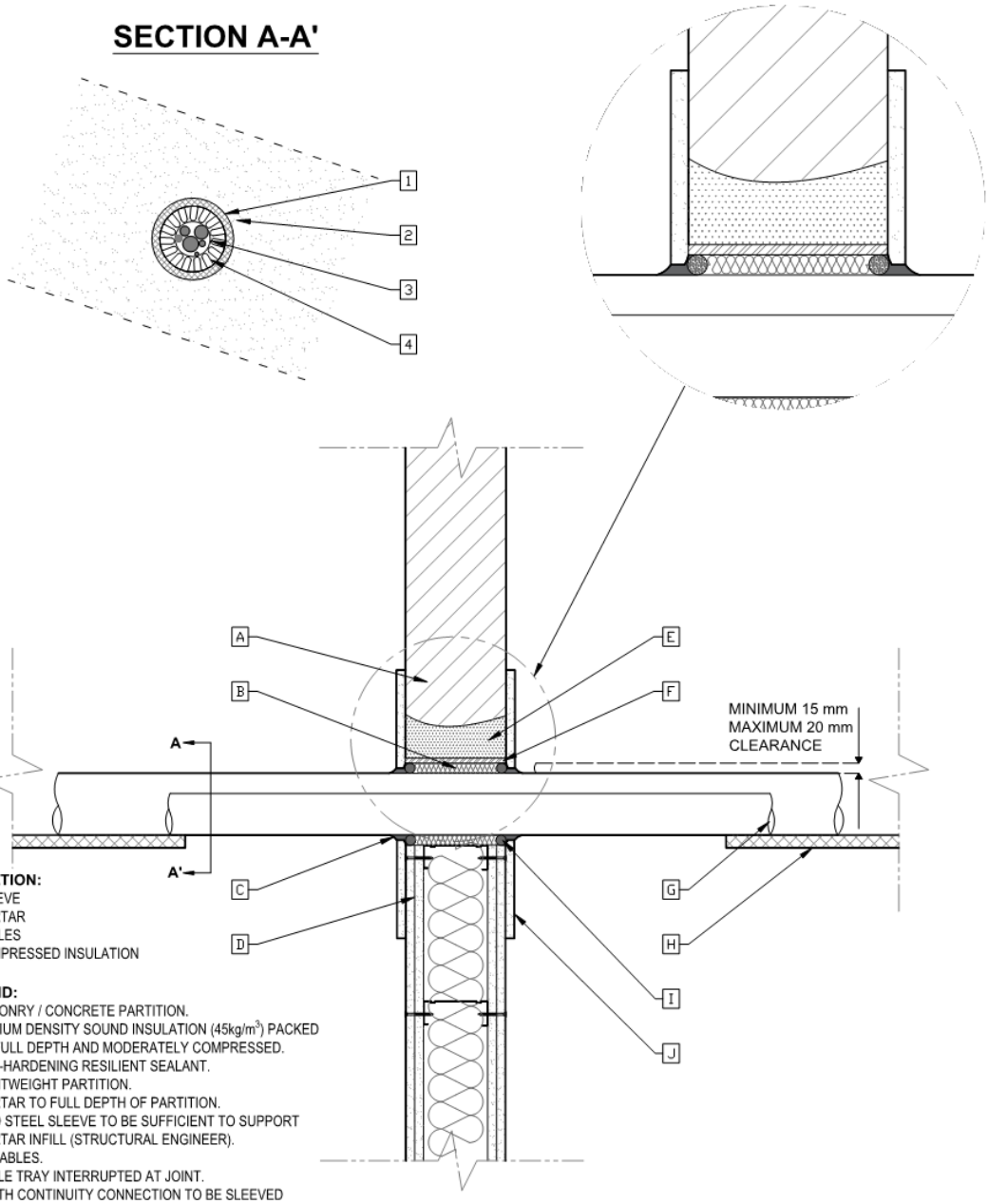
TITLE
ACOUSTIC SERVICES
DETAILING FOR ELECTRICAL CABLES - STANDARD SITUATION

DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
D.S.	J.R.	J.R.	N.T.S	08.10.2018

JOB No.	DRAWING No.	REV
180035	AC1103	P1

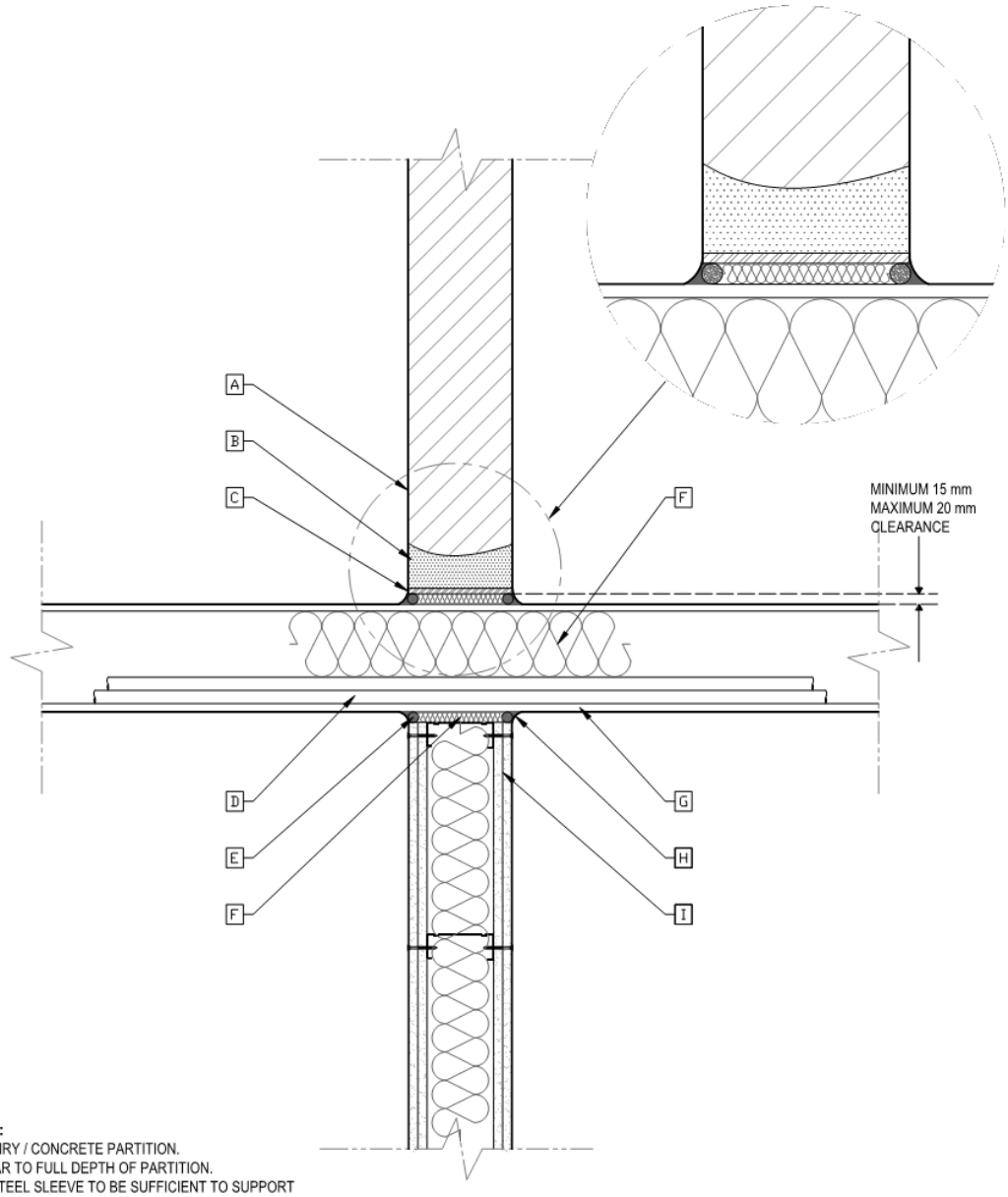
SECTION A-A'



ELEVATION:
1 - SLEEVE
2 - MORTAR
3 - CABLES
4 - COMPRESSED INSULATION

LEGEND:
A - MASONRY / CONCRETE PARTITION.
B - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
C - NON-HARDENING RESILIENT SEALANT.
D - LIGHTWEIGHT PARTITION.
E - MORTAR TO FULL DEPTH OF PARTITION.
F - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
G - LV CABLES.
H - CABLE TRAY INTERRUPTED AT JOINT. EARTH CONTINUITY CONNECTION TO BE SLEEVED WITH OTHER CABLES ON THE TRAY.
I - COMPRESSIBLE FOAM BACKING ROD.
J - 13 mm PLASTERBOARD COVER PLATE OR OTHER APPROVED BUILDING BOARD (MINIMUM SURFACE MASS 10 kg/m^2) BEDDED IN RESILIENT SEALANT (COVER PLATE SEPARATED FROM CABLE BY 2-3 mm)

CONSULTANT	TITLE	DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
JHA Level 23, 101 Miller Street, North Sydney NSW 2060 Australia +61 (02) 9437 1000 general@jhaengineers.com.au www.jhaservices.com	**ACOUSTIC SERVICES** DETAILING FOR ELECTRICAL CABLES - CRITICAL SITUATION	D.S.	J.R.	J.R.	N.T.S	08.10.2018
		JOB No. 180035	DRAWING No. AC1104			REV P1



LEGEND:

A - MASONRY / CONCRETE PARTITION.
B - MORTAR TO FULL DEPTH OF PARTITION.
C - MILD STEEL SLEEVE TO BE SUFFICIENT TO SUPPORT MORTAR INFILL (STRUCTURAL ENGINEER).
D - LV CABLES
E - COMPRESSIBLE FOAM BACKING ROD.
F - MEDIUM DENSITY SOUND INSULATION (45kg/m^3) PACKED TO FULL DEPTH AND MODERATELY COMPRESSED.
G - CABLE TRUNKING
H - NON-HARDENING RESILIENT SEALANT.
I - LIGHTWEIGHT PARTITION.

CONSULTANT	TITLE	DRAWN	CHECKED	APPROVED	SCALE @ A4	CREATED
JHA Level 23, 101 Miller Street, North Sydney NSW 2060 Australia +61 (02) 9437 1000 general@jhaengineers.com.au www.jhaservices.com	**ACOUSTIC SERVICES** DETAILING FOR ELECTRICAL TRUNKING - STANDARD SITUATION	D.S.	J.R.	J.R.	N.T.S	08.10.2018
		JOB No. 180035		DRAWING No. AC1105		REV P1

APPENDIX C: MECHANICAL SERVICES SCHEDULE

	ID	CU-01	FCU-01 / FCU-02 / FCU-10 / FCU-11	FCU-03 / FCU-04	FCU-05	FCU-06 / FCU-09	FCU-07
	Manufacturer	Daikin	Daikin	Daikin	Daikin	Daikin	Daikin
	Model	REYQ12TY1	FXZQ25AVM	FXMQ63PVE	FXMQ50PVE	FXFQ25PVE8	FXMQ40PVE
Sound Pressure Level (dB ref 20μPa)	63	63	32	32	36	25	35
	125	64	34	45	43	29	41
	250	58	35	40	40	31	39
	500	59	33	38	38	28	35
	1000	53	27	39	37	25	35
	2000	51	21	34	31	18	31
	4000	44	19	27	24	15	25
	8000	37	18	19	22	12	17
	Comments	Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard	Measured as per JIS standard

ID		FCU-08
Manufacturer		Daikin
Model		FXFQ32PVE8
Sound Pressure Level (dB ref 20µPa)	*63*	34
	125	36
	250	34
	500	33
	1000	28
	2000	21
	4000	17
	8000	14
Comments		Measured as per JIS standard

ID		EAF-01		OAF-01		OAF-02	
Model		Fantech PUEEC35		Fantech PCE404ER		Fantech Jetline-100ECO	
		Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Sound Power Level (dB(A)	*63*	65	65	65	65	48	44
	125	65	67	65	67	40	43
	250	61	63	61	63	43	43
	500	56	58	56	58	43	43
	1000	53	59	53	59	39	38
	2000	54	58	54	58	38	36
	4000	53	56	53	56	37	37
	8000	47	50	47	50	25	24
Comments							

ENGINEERING SPECIFICATION FOR HYDRAULIC SERVICES

RAIR FAIRY MEADOW

ISSUE	COMMENT	DATE	AUTHOR	CHECKED	AUTHORISED	JOB NO.
A	TENDER ISSUE	05/08/22	S.L.	S.T.	S.L.	210067
1	CONTRACT SET ISSUE	30/09/22	S.L.	S.T.	S.L.	210067

JHA CONSULTING ENGINEERS

LEVEL 23

101 MILLER STREET

NORTH SYDNEY NSW 2060

PH: (02) 9437 1000

JHA

JHASERVICES.COM

TABLE OF CONTENTS

SECTION 1 - GENERAL CAUSES

1.1 COMPLIANCE

The Head Contract GENERAL CONDITIONS OF CONTRACT and GENERAL CLAUSES of the main specification shall apply to this specification as though herein written in full.

1.2 EXTENT OF WORK

The work under this section covers the complete supply, installation and testing of the following:

1. General Clauses
2. Drainage Systems
3. Sanitary Plumbing
4. Cold Water Service
5. Hot Water Service
6. Fire Extinguishers
7. Sanitary Fixtures, Taps and Outlets
8. Fire Hydrant, pumps & tanks

1.3 SERVICE DRAWINGS

The accompanying drawings indicate the general layout of the plumbing work and are diagrammatic only. The Contractor shall allow for all necessary diversions and minor adjustments to pipework and equipment as may be necessary to complete the works.

1.4 REGULATIONS & AUTHORITIES

The whole of the work shall be carried out by or under the full supervision of a licensed plumber and licensed drainer in accordance with the drawings, specifications and to the satisfaction of the Local Inspector, Project Manager and any other Authority having jurisdiction over the work including:

1. Sydney Water
2. Fire & Rescue NSW
3. National Construction Code (NCC), Formerly Building Code of Australia
4. Jemena
5. Electricity Authority
6. SAA Wiring Rules
7. NSW Fair Trading
8. SafeWork NSW

The Contractor must obtain certificates from the Authorities indicating satisfactory completion of the services.

1.5 WARRANTY

All plant, equipment and materials supplied under this Contract must be covered by a minimum twelve (12) months warranty against faulty manufacture, workmanship and/or materials. The Contractor shall be responsible for the design, rectification and/or replacement of any portion of the installations.

The warranty period shall commence as from the date of occupation or replacement, as applicable but extension of the period shall I be made in respect of replaced portions only. This warranty shall be in addition to any manufacturer's warranty supplied with plant equipment or materials.

1.6 DEFECTS LIABILITY

Rectify all defects in the work due to faulty materials and/or workmanship for twelve (12) month period commencing from the date of occupation. Such defects shall be made good immediately on receipt of advice of defect.

Any defects discovered during the twelve (12) month period which are due to default, negligence, performance of the obligations shall extend the period to enable such defects to be made good and to allow the whole work after being made good in every way to be proved satisfactory.

1.7 ROUTINE MAINTENANCE REQUIREMENT DURING THE TWELVE MONTH DEFECTS AND LIABILITY PERIOD

The hydraulic trade shall undertake inspection services and carry out maintenance as scheduled below during the twelve month defects and liability period.

System Component	Task	Timing
Pumps	Activate each pump to start in correct order	3 months
Pumps Electrical Control Panels	Check that all controls are functioning in accordance with design requirements. Check with owner or building manager regarding operation of panel indicator lights. Correct, repair any non-functioning control or indicator lights.	3 months
Water level Sensors, Pressure Switches and System Shut Down Valves	Check that all sensors and switches activate the correct mechanism	3 months
Mains Pressure Hot Water Heaters	Activate temperature and pressure relief valve and ensure valve reseats	3 months
Thermostatic Mixing Valves	Remove and clean strainers on cold and hot pipe sides. Check warm water temperature	3 months
Hydraulic Services Pipes and Valves	Inspect for leaks	3 months
Urinal Automatic Flushing	Check that sensor automatically activates solenoid valve within acceptable time period	3 months
Tapware	Inspect for water drips when tap in closed position	3 months
Reduced Pressure Zone Devices (RPZD)	Remove and clean strainer on inlet side	3 months

1.8 FEES AND APPROVALS

The Contractor must pay all fees to Authorities for connection, approvals, testing and inspections, required for this project.

1.9 SITE CONDITIONS

The Contractor is obligated to inspect the site and satisfy himself as to the conditions under which the work will be carried out.

1.10 CERTIFICATE OF COMPLIANCE

Provide to the Authority and the Project Manager a Certificate of Compliance clearly noting the completion of all plumbing and drainage works. A Certificate of Compliance shall also be issued in relation to the Natural Gas Services to the Authority and the Project Manager.

1.11 TRAINING OF MAINTENANCE STAFF

Upon completion of the project or hand over of separable portion as directed, allow for full and comprehensive training of the Client's Maintenance staff in all aspects of the Hydraulic Services Operations. Training shall include a step by step guide through the As Installed Drawings and the

Operating and Maintenance Instruction Manual with on-site inspection, operation and demonstration of plant and equipment for all items indicated in the As Built drawings and Operation Manual.

1.12 WORK BY OTHER TRADES

The following schedule is issued as a guide to work associated with the hydraulic services works.

Builder & Carpenter

1. Ducts, access panels and inspection panels.
2. Roof gutters.
3. All access panels to ceiling space.
4. Supply and Installation of sink benches.
5. Grading of shower recesses.
6. Supply and installation of vanity basin benches.
7. Concrete work for grated drains.
8. Datum and grid line set outs at floor level and for external set-out.
9. Bench and cupboard units with suitable openings for the installation of sinks and basins.
10. Waterproof membrane to walls and floors.
11. Forming of trench drains (supply and fixing of grating, checking set-out overview of concrete placement and levelling of falls by Hydraulic Trade).
12. Removal and replacement of bitumen and concrete road surfaces and concrete pathways where pipes are to be installed.
13. Laundry, Kitchen and Serveries stainless steel sanitary fixtures, Tapware and water outlets.
14. Installation of steel purlins above roof to support solar absorber panels.

Electrical

Electrical supply to all equipment requiring power, to control panels & direct to equipment where required including:

1. Sewage pumps.
2. Hot water return pumps.
3. Isolating switch for hot water circulating pumps.
4. Electric wiring to Hot Water Units.
5. GPO for washing machines.
6. GPO boiling water and chilled water units.
7. Electrical Wiring into Control panels for sump pumps.

Roofer

1. Provision and fixing of all roof flashings where vent, flue or other pipes/services pass through roof covering.
2. Hanging straight and hanging stepped roof flashings.
3. All eaves gutters.
4. All external rainwater down pipes.

Mechanical Services

1. Extension of condensate drainage from AC equipment and plant to tundishes, floor wastes and pipe turn-ups (including seal by Mechanical Contractor) provided in the Hydraulics work.

1.13 ACOUSTIC TREATMENT

Provide acoustic treatment / insulation to all pipework, plant, equipment and associated fixings and in accordance with the Acoustic Engineer’s report/requirements, Architect's requirements, National Construction Code of Australia and Authorities requirements. Insulation shall be complete with continuous vapour barrier over wrap.

1.14 ELECTRICAL WORK

All electrical work to be installed under this contract shall be carried out by a licensed electrician and in accordance with the electrical requirements for this project, the S.A.A. Wiring Rules and the requirements of the local supply Authority.

1.15 CO-ORDINATION

The Contractor must co-ordinate his work with other trades and the construction programme and follow-up all other trades as fast as the works proceed.

1.16 WORK AS EXECUTED DRAWINGS

The Contractor shall deliver to the Project Manager before application for Notice of Practical Completion for checking one copy of the work as executed drawings, accurately indicating the invert depths and installed position of all services, fixtures, fittings, valves, including diagrammatic, details drawings and maintenance manuals.

Any necessary corrections will be made and a further copy of the work as executed drawings submitted to the Project Manager for checking.

Once all necessary corrections required by the Project Manager are made to the drawings, three (3) copies of the drawings and 1 CD in CAD Format and the maintenance manuals shall be issued to the Project Manager.

1.17 MAKING GOOD

The Contractor shall be responsible for and shall make good to all surfaces and any other works that may be disturbed or injured by cartage, work generally or other operations. The reinstatement shall be at least as good a state of repair as before commencement.

1.18 DAMAGE TO SERVICES

Before work commences, check the location of all services, immediately notify the Superintendent and the Officer of the relevant Authority in charge of the area in the event of damage to any water, gas, electric, drainage, sewerage, telephone, fire alarm, control cable, optic fibre or other services in the area. Render any assistance required in connection with any such incident, but otherwise work in that vicinity shall be stopped immediately and not recommence until instructed by the Superintendent.

1.19 PROTECTION

Provide all apparatus, equipment in connection with the work. Special care shall be taken to protect all parts thereof in such a manner as may be necessary or as directed. This protection shall include covers, crating, sheds, stores, or other means to protect the apparatus, equipment and materials from the weather and to prevent dirt, grit, plaster or other foreign substances from entering the working parts of machinery or equipment.

Keep all open ends of pipes, ducts and flues closed while in storage or during course of installation.

1.20 CORE HOLES AND SLEEVES

The Contractor shall set out all core holes and sleeves in floors, walls, beams and columns in conjunction with the fixing of formwork and/or placing of concrete.

Protect all parts of the building and the work of other trades from damage which may be caused by the Contractor's workmen or Contractors. Make good any damage.

1.21 DIMENSIONS

The Contractor shall be responsible for taking all dimensions on site. The dimensions must be checked before work is commenced all levels and dimensions of existing services must be confirmed before

commencing work. The invert levels shown on the drawings are recommended only, and must be checked on site before excavation or installation of pipework to ensure connection to supply sources are correct.

1.22 FIXING AND SUPPORTING OF PIPES

Service pipes shall be positioned in approved locations before installation or fabrication of pipework commences.

Pipes shall be adequately supported and secured to adjacent walls and slabs.

Pipework shall not come into contact with any other service pipes or part of the building structure, except pipes in wall chases.

Pipework shall not be either permanently or temporarily fixed in position by the use of nails.

Should leaking pipework occur due to electrolytic corrosion between the pipework and the nails, then the contractor shall be responsible for all costs associated with the repair including pipework, walls, finishes, etc. whenever the leaks may occur.

1.23 CHASING OF PIPES

All chasing in masonry walls for pipework shall be carried out by the Contractor with a mechanical saw. All proposed wall chases shall be approved by the structural engineer before chasing proceeds. Generally avoid horizontal wall chases.

Note: All chased pipework shall be lagged.

1.24 WATER HAMMER

Before concealing of any water service pipework the Contractor shall carry out an operational test for water hammer.

Should there be any evidence of water hammer within the water services, the contractor will be required to remedy the problems at his own cost. Should any pipework be concealed prior to testing, and water hammer exist, then the Contractor will be required to remedy the problems and make good all surfaces, structure, fittings and fixtures.

1.25 PENETRATIONS AND SLEEVES

Set out all work and be responsible for accurate positioning and installation of all penetrations, core holes, water stop flanges and sleeves in conjunction with the fixing of form work and/or placing of concrete, brickwork and concrete cutting or core drilling.

To prevent weakening of the building structure, all penetrations shall be approved by the Structural Engineer through the Superintendent.

Generally all major penetrations in pipe ducts and shafts shall be purpose made to the required size and accurately positioned and supported. All others shall be core hole "Slabseal" plastic water stop assemblies accurately positioned and symmetrically provided for all pipes passing through floors.

Water stop flanges shall be provided to all pipes, plantroom sumps, roof outlets, floor wastes and pipes passing through floors and walls including basement perimeter wails, or wherever the possibility exists for water leakage. Each water stop flange shall be of the same material as the pipe served with an external diameter twice the diameter of the pipe. The flange shall be integral to the casting or welded, brazed, silver soldered or sealed as applicable.

Sleeves shall be fitted to all pipes passing through walls, floors and beams. Sleeves shall be 25mm diameter larger than the outside diameter of the pipe being served and project 50mm above finished floor level in ducts and 10mm from walls. The space between pipes and sleeves shall be caulked and sealed with an approved fire rated material.

All penetrations shall be fire rated to an equivalent rating of floor or wall. Ensure all required fire and acoustic ratings are achieved with the selected installation method.

1.26 CERTIFICATE OF FIRE STOPPING

At the conclusion of the work, provide a written guarantee that all fire stopping of penetrations have been carried out in accordance with the manufacturer's directions, and do not impair the fire resistance performance of the building element in which it is installed.

The written guarantee shall include a schedule of all penetrations through fire rated structures nominating the location, vertical or horizontal penetration, size and method of achieving fire rating.

1.27 FIXTURES AND FIXTURE POINTS

The Contractor shall supply and install all materials, backing plates and noggins necessary to make all fixtures and fixture outlet points rigid (i.e. sanitary fixtures and tap fittings).

1.28 EXERCISE CARE OF PUBLIC UTILITIES AND EXISTING SERVICES

Where underground public utility lines, surface drainage works and underground pipes, conduits or cables exist in the vicinity of the works, the Contractor must take care to protect such services. The cost of the necessary repairs or renewals shall be paid for, entirely by the Contractor, should negligence on the Contractors part be proven.

1.29 EXISTING SERVICES

Determine the exact location and position of all existing services on and adjacent to site prior to commencing work.

Allow for the disconnection, alteration, sealing off, connection to or from, extension of or removal of services to maintain supply to existing buildings and fixtures.

Prior to disconnection, sealing off, or modification to any service, a thorough check shall be made on site to ensure no service which is required to be retained is adversely effected.

Provide all temporary pipes, fittings, valves and sundry items necessary to maintain supply to existing buildings.

All shutdowns and connections shall be performed in a way to ensure minimal inconvenience to the existing users.

1.30 REDUNDANT SERVICES

Disconnect and remove redundant services and to the approval of the Authority having jurisdiction.

Report all site modifications, diversions and/or disconnections affecting the work. Provide necessary assistance for the resolution of such difficulties in conjunction with the Project Manager.

Prior to any site modifications, diversions and/or disconnections, provide all temporary pipes, fittings, valves and sundry items necessary to maintain the supply to the building.

1.31 SUPPLY OF MATERIALS

Supply all materials necessary for the work covered by this specification. All materials and finishes which are deemed not in accordance with this specification will be rejected and replaced with materials to comply with the instructions issued by the Project Manager at no extra cost to the Project.

1.32 SAMPLES

When required or specified, submit to the Project Manager identified duplicate samples of any materials or items specified to be used in the works. One each of the approved samples shall be signed by the Project Manager and returned to the Contractor and the other shall be kept on the works in a safe place and available for inspection.

Where due to the nature of materials or item concerned, the above procedure is impractical, make reasonably available an identified sample for the Project Manager’s inspection.

1.33 SURVEY

On completion of the works provide "As Built" drawings from a registered surveyor of all pipes installed in-ground including water, gas, sewer, trade waste and stormwater drainage pipe system and certifying pipe sizes, invert levels, location of isolation valves.

Also provide “As Built” plans indicating the routes of all internal pipework including indication of the location of all isolation valves and pieces of plan and equipment.

1.34 DRAWINGS AND DIMENSIONS

Hydraulic Contract Drawings

Pipe work and levels indicated on drawings are recommended only. Check on site before excavation or installation of pipework to ensure correct cover and fall. Submit proposed alterations to inverts and obtain approval before starting work.

Check dimensions on site before work is put in hand or prefabricated.

The drawings are issued as a guide only and shall be considered to be diagrammatic and approximate. The drawings and Specification are intended to be mutually explanatory and complete, but all work called for by one, even if not by the other, shall be fully executed. Should the documents be in conflict, it shall be deemed to have been included for the larger quantity and/or the more expensive components, as applicable.

Ensure that adequate detailed and dimensioned drawings have been co-ordinated with all other services and have the approval received of the Project Manager before the commencement of any trenches, pipework, fixtures and fittings.

Workshop Drawings

Prepare all necessary co-ordinated manufacturing and installation workshop drawings covering the works. Confirm final installation dimensions by site measurement, to ensure satisfactory set out and coordination with the structure and new or existing services.

All workshop drawings shall be AutoCAD 2012 drafted and submitted on paper print form in quantities as required. Such drawings shall be submitted to the Main Contractor for checking.

Manufacture and/or installation as applicable shall not be commenced prior to the Project Manager's approval of the workshop drawings.

The workshop drawings to be prepared and submitted shall be 1:100 scale for floor plans and 1:50 / 1:20 scale for plantrooms and equipment details and shall include the following:

a. Manufacturer's drawings of purpose made equipment.
b. Name, address and telephone number of manufacturer of equipment.
c. Drawings showing the extent of the work.
d. Detailed plans and sections showing the services installation including position of control equipment.
e. Wiring and schematic diagrams of each item of equipment.

Approval of work shop drawings shall be given in principle only without responsibility for the proper co-ordination, installation and operation of the services.

The preparation of workshop drawings shall be scheduled to enable the necessary approvals to be gained and to comply with the program for installation of the services.

Submit three prints of each workshop drawing to the Project Manager and submit to the appropriate Authorities as necessary for their approval.

As-installed Drawings

Prior to practical completion of the Contract works, supply three (3) CAD discs in AutoCAD 2010, in PDF and DWG formats of all drawings and three (3) sets of hard copy prints showing the complete services installation as-installed complete with detailed dimensions of all services and branch lines. The above disks and prints shall be included within the operating and maintenance instructions.

The drawings shall be to the same scale as specified for "Workshop Drawings" and shall record details of the work actually installed and titled "As Installed".

In order to achieve accurate drawings, all relevant information relating to the Contract work shall be entered onto working drawing prints immediately it has been carried out. The information shown on prints and final records shall be actually physically measured from permanent buildings, boundaries or other permanent features. Also refer to specification clause referring to Survey of in-ground piping systems.

1.35 MAINTENANCE MANUAL

Prepare three (3) copies of an instruction manual prior to practical completion which shall include the following sections and information:

a. A general description of services under all modes of operation.
b. Locations of all mains connection points.
c. Emergency procedures.
d. A fully detailed preventative maintenance procedure and maintenance schedules.
e. Maintenance information and manufacturer's brochures for all fixtures, valves and items of plant.
f. Recommended spare parts and contacts for supply.
g. Locations of all systems controls.
h. Wiring diagrams of all electrically powered hydraulics equipment.
i. "As installed" hydraulics drawings clearly identifying pipework and equipment,
j. Methods for basic fault finding.
k. Certification of systems by the relevant Authorities and/or installer.
l. Recommended maintenance procedures and equipment maintenance intervals.
m. New development drainage sewer plan to 1:500 scale. This is to include existing sewer drainage services on site.

The manuals shall be A4 size and each page of the manual shall be heavy quality paper. The hard cover shall be light plastic material and shall secure each page at a minimum of four (4) points.

The manuals shall be clearly identified as "DRAFT “or “APPROVED” as relevant to the version of the manual.

The "approved" manuals shall be provided to the Project Manager at the completion of works.

1.36 FLUSHING OF PIPELINES

On completion of each section of the work or part thereof and prior to the installation of any valves or appliances, the relevant service pipeline shall be thoroughly flushed out to remove all debris and foreign material. Thoroughly flush out existing services prior to connection.

1.37 EXCAVATION

1. General

Allow for all excavation to be in MATERIALS AS FOUND. A copy of the Geotechnical Report is included in the contract documents for reference. Allow for excavation to required depths in material identified.

2. Precaution and Safeguards

Carry out the work in a careful, secure, safe and tidy manner and take all precautions against damage whether arising from bad workmanship, breakage of machinery or plant, inefficient timbering, flooding or any other cause whatsoever. Provide, erect and maintain warning signs, temporary fences, barriers and night lights adjacent to any works such as trenches and excavations or stacks of material which could be considered a danger to persons or traffic of any kind.

Obey all directions given with regard to the provisions of lighting and barriers, and be responsible for any accident or damage. Obtain permission from Authorities, when required, for placement of barricades.

3. Use of Explosives

The use of explosives will NOT be permitted.

4. Trench Excavation

Excavate in the form of trenches to enable various pipe lines to be constructed. Trenches shall be excavated at uniform grades and in straight lines.

Provide adequate de-watering equipment to maintain trenches free of water. Ground water shall be pumped to discharge clear of the excavation area.

No earth, rubbish or materials shall be unnecessarily deposited upon pavements, footways or crossings.

5. Hoisting and Removal of Spoil

Allow to hoist spoil and remove from site.

1.38 SURFACE REINSTATEMENT

Reinstate all surfaces or make good as directed by the Project Manager those surfaces that are damaged or removed as part of the installation works. Reinstatement work shall be carried out so as to match the surrounding surfaces and shall be left in a condition at least equal to that in which it was prior to the installation works, including reinstatement of existing turf.

1.39 BACKFILLING

Prior to any backfilling being placed the drainage lines shall be inspected by the Project Manager and/or representative who, if satisfied, shall indicate that backfilling may proceed.

Placing and Cover - backfilling shall be carefully packed and consolidated by mechanical means.

All trench backfill in trafficable areas shall be consolidated with approved material to 98% standard compaction.

All pipes shall have a minimum cover of 500mm, except where a cover of structurally designed reinforced concrete is provided.

1.40 SAW CUTTING OF EXISTING SURFACES

Saw cut existing concrete and bitumen surfaces as required to install new pipelines. Obtain approval of Superintendent prior to commencement of work. Break up and remove spoil from site.

Allow to pay transport and tip costs.

1.41 BRACKETING AND SUPPORTS

a. Pipes shall be adequately supported and secured in an approved manner.
b. Pipes shall not be fixed to, supported by, or welded to other pipes.
c. Pipework must be free to move without causing stresses in the pipework or pipe joints. Where provision has been made for movement in mains, the branch lines shall be unrestrained and in the case of copper tube, annealed for a minimum of 1500 mm from the main. Where this is not achievable, some other approved provision for movement shall be made. Vertical pipes passing through floors shall be supported at maximum 2400mm centres.
d. Support all pipes with galvanised concrete inserts, galvanized steel channels, galvanized steel pipe clamps, and galvanized steel pipe hangers, etc., in accordance with the manufacturer's instructions and complying with the catalogue regarding spans and loads.
e. Secure all supports and necessary sanitary fixtures with "Dynabolt" or equal approved metallic anchors.
f. Power-driven fixings, wooden plugs or screw-ins shall NOT be used.
g. Fixing and supports shall generally comply with the following:

Pipe Hangers

Hangers for supporting piping shall be of rolled steel sections of minimum dimensions as follows:

Pipe Size	Hanger Dimensions
Up to 65mm	10mm diameter
66mm to 125mm	12mm diameter
126mm to 225mm	16mm diameter
Over 225mm	to Australian Standard

Where vertical pipes are exposed in rooms, they shall be secured at floor and ceiling and shall have at least one intermediate support.

Span of Supports for Pipes

The distance between both horizontal and vertical pipe supports must not exceed the distances nominated in the Australian Standards for the respective service:

1.42 PAINTING AND IDENTIFICATION

Except where otherwise specified or directed all internal exposed piping throughout, adjacent to plumbing fixtures including traps and fittings shall be chromium plated. Where exposed pipes pass through a finished wail, floor or ceiling they shall be fitted with approved chromium plate.

All piping shall be cleaned free of cement droppings, etc. All piping shall be provided with a 450 mm long colour band to the requirements of AS 1345.

Colour bands shall be at a maximum of 3000 mm centres.

Markers shall nominate type of service and direction of pipe flow.

Additional markers are to be installed:

a. on both sides of wail or partition through which a pipe passes;
b. adjacent to tees, valves, outlets, pumps and items of plant.
c. on both legs of a bend;
d. on both sides of a pipe which can be approached from two or more directions;
e. on pipes at the inlet and outlet of each piece of plant equipment;
f. on riser pipes at each floor level.

Valves are to be labelled with a circular plate of Traffolyte material or similar engraved with their respective function and mounted in an approved manner on top of valve spindles with brass ring.

The service colour coding shall be:

Item	Colour (AS 1345)
Soil Wastes & Vent Pipes	Black
Stormwater Drainage Pipes	Dark Admiralty Grey No. 632
Cold Water	Emerald Green No. 220
Hot and Warm Water Flow	Brilliant Green No. 221
Gas Service	Yellow Ochre
Bracketing	To match pipe it is supporting

1.43 CHASES AND ENCASING

All internal walls that are brick shall not be chased unless approval has been requested and approved. Obtain approval of the Structural Engineer through the Project Manager prior to commencement of work.

Common walls separating resident’s rooms or wall separating bedrooms from plant and service rooms shall not be chased.

Cut all chases with a mechanical saw. Do not chase reinforced concrete work without approval.

Pipes chased into masonry or encased in concrete shall not cross any movement joint and shall be insulated so that expansion and contraction can take place without damage to the pipe or to the material or surface finish of the surrounding element.

Conduit pipes encased in concrete shall have a minimum cover of 25mm of concrete and shall be in continuous lengths without fittings unless the fittings are permanently accessible.

Refill chased cavities with 2:1 cement mortar mix or approved equal after pipe has been installed.

1.44 COPPER TUBES AND FITTINGS

Copper tubes shall be solid-drawn in accordance with the following standards:-

a) Water Service Pipes shall be to AS 1432, Type "B"
b) Soil and Waste Pipes shall be to AS 1432, Type "B"
c) Vent Pipes shall be to AS 1432, Type "D"
d) Gas pipes shall be to AS 1432, Type "B"

Fittings shall comply with the respective Australian Standard.

1.45 CROSS LINKED POLYETHYLENE PIPE & FITTINGS

Pipe materials shall be PE-Xa/PE construction, consisting of PE-Xa inner layer and a PE outer marking layer, certified to AS/NZS 2492 for water service applications.

Suitable for use in hot and cold water applications in buildings in accordance with AS/NZS 3500.

Water services pipes - not less than PN 20

Fittings: Brass Dezincification Resistant as to AS 3688.

Jointing Method: Compression fittings and sleeves

- Connections shall be axial compression sleeve mechanism
- Self-sealing pipe material – connection without the use of an O-ring
- As per manufacture instructions

Fittings and sleeves shall be REHAU RAUTITAN PX or MX, Watermark approved and certified to AS/NZS 2537.

Tube in Concrete Slabs: Tubes which are to be installed within concrete slabs are to be run in PVC conduits and shall comply with the requirements of the appropriate building authority (AS 3500).

Prohibited Areas: Cross Linked Polyethylene will not be used in areas as specified in AS 3500.

LIMITATION OF PE-X

The following limitation apply for the use of PE-X pipe

- Purpose built brackets/hangers (approved by manufacturer) are only to be used.
- Only to be used for rough-in pipework for hot and cold-water services. I.e. downstream of apartment isolation valves/ meters.
- Not to be used for hot water systems with temperatures in excess of 60 degrees Celsius
- Not to be used where subject to pressure in excess of 600kPa
- Not to be used for pipe sizes in excess of Ø28mm
- Where cast in the slab, the product may be tested in accordance with AS 1530.4 - 2014

ALTERNATE PE-X PRODUCTS

Should the manufacturer wish to submit an alternate PE-X product they are entitled to provided that the alternative meets the following criteria:

- Evidence must be provided that the alternate product has been installed and functioning for a minimum of 10 years within Australia
- Warranties and insurances must be provided demonstrating that the alternate product has financial backing in Australia
- All installers must be certified /trained by the relevant manufacturer.
- All tools must be certified as per the relevant manufacturer's recommendations.
- All tools must be recertified as per relevant manufactures recommendations and log books retained on site for inspection.
- Allowance is to be made to allow manufacturer to undertake site checks of works as works are progress and detailed reports issued for each visit. Frequency of site visits to be dictated by site progress but minimum of 50% of installed works to be inspected.
- Allowance to be made for random sections of pipe and fittings to be taken (before installation) for testing by independent tester, to ensure quality of pipe in accordance with manufactures literature. This must be tested and returned with certified results within 7 days.
- The relevant manufacturer must have a QA procedure in place which provided traceability for:
    - Country of origin
    - Date of manufacture
    - QA sheets for each batch

1.46 POLYETHYLENE SLEEVING FOR PROTECTION OF COPPER PIPELINES

All in-ground copper pipework and fittings shall be protected with polyethylene sleeving. Sleeving to pipes shall comprise polyethylene tube. Polyethylene sheet shall only be permitted as sleeving at fittings and valves, or for the repair of damaged tubing.

1.47 POLYETHYLENE *(PE)* PIPES AND FITTINGS

PE pipes shall be first quality, conforming to AS 4130.

PE pipes and fittings shall be installed using electro-fusion socket type joints.

1.48 FIRE SEALS

Where PVC pipework penetrates fire rated element such as floors and walls, allow to provide a fire seal to the required fire resistance rating for the element.

1.49 JOINTING MATERIALS

a) Silver solder shall contain not less than 5% silver.
b) Cement shall be Portland cement type "A".
c) Rubber Ring Gaskets to AS 1693 of approved manufacture.
d) uPVC pipes shall be jointed by solvent welding of the type recommended by the manufacturer.

1.50 VALVES

All valves used shall be standard marked.

1.51 UNDERGROUND ISOLATION (PATH) VALVES

All valves used shall be standard marked.

Underground valves must be ball type, resilient seated and have a blow-out proof stem equal to Zetco Series 2505. The valve drive must be a 40mm tall square head socket and meet the standard dimensions of 28.5mm square at the top tapering to 31.75mm at the base.

1.52 CAST IRON SURFACE BOXES

Supply and install cast iron surface boxes marked as per service over all underground valves.

Surface boxes shall be surrounded with concrete and shall be provided with a 150 mm diameter uPVC pipe riser extending up from the valve spindle.

1.53 INSULATION MATERIALS FOR IN WALL WATER SERVICE PIPES

Cold, hot and warm water copper pipework where installed within masonry wall, shall be pre-insulated, Kemlag covered, copper tube.

1.54 CONCRETE

Concrete shall be of 20 MPa strength when supplied by a ready-mixed concrete supplier, or site mixed concrete shall be of 4:2:1 mix. Mortar shall be 2:1 cement mix.

1.55 PITS AND SUMPS

Excavate, supply, install and backfill around pre-cast concrete pits and sumps to the dimensions locations as shown on the Hydraulic Service Drawings.

Nylon coasted step rungs shall be installed in pits and sumps over one (1) metre deep. Covers, grates and frames shall be as shown and specified. Bench up base to match pipe size.

Where pits and sumps are to be installed within concrete paving or floor slabs they shall be installed complete with starter bars to adequately prevent uplifting of the pit

1.56 COVERS, GRATES AND FRAMES

Unless nominated on drainage covers, grates and frames shall be cast iron with all edges machine fitted and have removable plastic lifting hole plugs.

All grates shall be heel guard with max openings 13mm x 150mm complying with AS 1428.

1.57 BEDDING MATERIALS

After length of trench has been approved the following bedding material shall be placed therein to approval:

a) PVC Pipes for sewer drainage shall be bedded on a compacted 75 mm thick layer of blue metal (9.5 mm maximum).
b) PVC Pipes for stormwater drainage shall be bedded on a 75 mm thick layer of blue metal (9.5 mm maximum).
c) Precast Concrete Pipes shall be bedded on a 150 mm layer of coarse river sand.
d) Nylon pipes shall be bedded on a 150 mm layer of coarse river sand.
e) Copper and Polyethylene water pipes shall be bedded on a 150mm layer of coarse river sand.

1.58 OVERLAY MATERIALS

After length of trench has been approved the following overlay material shall be placed therein to approval:

a) Sewer PVC drainage side support and pipe overlay material shall be equal to the bedding material with a minimum 100mm overlay.
b) Stormwater PVC drainage side support and pipe overlay material shall be equal to the bedding material with a minimum 100mm overlay

c) Precast concrete pipes side support and pipe overlay material shall be equal to the bedding material with a minimum 150mm overlay or as per the manufactures' recommendation, whichever is the greater.
d) Precast concrete pipes side support and pipe overlay material shall be equal to the bedding material with a minimum 150mm overlay or as per the manufacturers' recommendation, whichever is the greater.
e) Copper and Polyethylene pipes side support and pipe overlay material shall be equal to the bedding material with a minimum 150mm overlay.

1.59 CAPPING OFF PIPELINES

During construction, temporarily seal floor wastes, open ends of pipes and valves to prevent the entry of foreign matter into pipe systems. Provide fitted covers of pressed steel or plastic. Do not use rags, paper or wood plugs.

1.60 TESTING OF PIPE SYSTEMS

All tests set out in the specification or as required by the respective governing Authority shall be carried out to approval. Supply all plugs, apparatus and sundries necessary for the test. Enclosed work shall not be covered or concealed from view until it has been inspected, tested and approved.

On completion, all works shall be tested under normal working conditions, in accordance with the Authority's requirements and as may be further directed to prove compliance with the specified requirements of the works. All defects are to be remedied immediately and the test reapplied until a satisfactory result is obtained.

Sewer Drainage -	Hydrostatic Test
Sanitary Plumbing -	Hydrostatic Test
Stormwater Drainage -	Hydrostatic Test
Water Services -	Hydrostatic Test up to 1500 kPa
Fire Services -	Hydrostatic Test up to 1700 kPa
Natural Gas Service -	Nitrogen Gas Pressure Test as per AS5601.1:2013

All test results shall be recorded and made available at the site office upon request.

1.61 COMMISSIONING OF HYDRAULIC SERVICES

The hydraulic trade shall provide specially trained and skilled personnel to operate each of the hydraulic services installed for this project. Ensure that each system functions to full capacity under simulated hydraulic loads and flow rates. Provide additional valved connections to that indicated on the design drawings in order that testing can be undertaken.

System commissioning must include pressure testing, flow testing, system drain down and automatic and electrical control mechanisms through the full range of control functions.

Undertake thorough commissioning of the following:

1. Pump electrical control panels.
2. Pressure switch and flow switch activation.
3. Reduced pressure zone valves.
4. Thermostatic mixing valves.
5. Hot water circulating pump sets.
6. Sewage pumps sets.
7. Electrical storage water heaters.

SECTION 2 - DRAINAGE SYSTEMS

2.1 EXTENT OF WORK

The work specified in this section comprises the modification, supply, installation and testing of the various drainage systems including all necessary accessories, testing and commissioning of the systems.

The work includes the supply of all necessary fittings, inspection openings, and sundry items including dewatering of the ground. Make any necessary application to the Authorities and pay all fees and charges associated with the installation, testing and supervision of the work.

Sanitary Drainage System - comprises connection and extension from sanitary fixtures to the sewer pump station and connection to the authority sewer rising main. Includes removal of existing drainage pipes.

Trade Waste Drainage System – comprises of connection and extension from the vehicular wash bay to a holding tank and coalescing plate oil separator and all associated components

It is noted continuation of downpipes in ground, surface drainage, OSD, etc is documented in the civil package.

2.2 MATERIAL SCHEDULE

Pipes and fittings shall be in materials as follows:-

Service	Size	Material
Sanitary Drainage	65-100	uPVC (DWV). Solvent welded uPVC. Provide SN8 or SN10 uPVC pipe (SEH) where depth exceeds 2m. Exposed waste pipework to be copper and chrome plated.

2.3 P.V.C. PIPES AND FITTINGS

Pipes and fittings shall be uPVC (DWV) sewer quality and shall conform to the Authorities' requirements having jurisdiction and to AS 1260, AS 1462, and AS 2032.

2.4 POLYETHYLENE (HDPE) PIPES AND FITTINGS

HDPE pipe and fittings for gravity sewer or trade waste drainage shall be sewer grade jointed with electro-fusion socket type fittings.

2.5 TUNDISHES

Provide 50 x 40 (unless noted otherwise) chrome plated copper concentric reducers complete with pipe drainage connection to the sewer drainage system.

Tundishes shall be chrome plated complete with screwed outlet and cover dome at wall and floor penetrations.

All tundishes are to be located so they are not subject to mechanical damage.

Tundish locations shall be coordinated with mechanical contractor on site.

2.6 SEWER CONNECTION

Contractor shall allow for all fees to coordinate the connection of the private sewer to the council authority service. Refer to hydraulic site plan for connection details.

2.7 PIPE SUPPORT BRACKETS TO PIPES UNDER FLOOR

All pipe support brackets where installed in service trenches under the floor of the building shall be 316 grade stainless steel. This includes the hanging rod.

2.8 TRENCHES

Trenches for drains shall be parallel with the design invert of the drains. Additional material below the bottom of the drain shall be excavated as necessary to provide the required bedding conditions.

Trenches shall be excavated to such width as to provide a minimum space of 150mm between the innermost face of the trench and the outside edge of the drain

2.9 PIPE LAYING

General - all drains shall be laid and jointed accurately to lines, grades and levels. All pipes shall be laid so that the underside of pipes have solid bearing throughout their length.

Setting out - all pipes shall be set out and laid so that the intersection of the centreline (in the plan view) occurs at the downstream pit face.

Unless otherwise approved, laying shall commence at the low points of the drainage line and proceed uphill, with the spigot end of the pipe located downstream from the socket end.

Jointing - all pipes fitted with approved rubber joint rings shall be installed to the manufacturer's specifications.

Spacing - the distance between pipes in multiple pipelines shall be at least one third (1 /3) the external diameter of the pipe, or 300mm, whichever is the greater.

2.10 USE OF CONCRETE

Provide 20 MPa concrete not less than 100mm thick with exposed surface cement rendered as follows:-

a) Around pipes and fittings as required by the regulatory Authority;
b) Around and under traps and gullies;
c) Around exposed pipes and fittings;
d) Under and around bases of inclined junctions and bends.

Where regulation cover cannot be provided over drains, surround pipes with 150mm of 1:2:4 concrete.

2.11 FLOOR WASTES

In positions indicated “FW" provide 100mm "P" trap floor wastes with riser extended to 100mm CP brass drainage grate set at a level to suit floor grading.

Floor wastes (FW) in plant rooms shall be fitted with "Specialty Plumbing Services" manufacture galvanised flat and cast iron body with membrane flange.

2.12 QUARE TOP. STONE/TILE INSERT FLOOR WASTES

In positions indicated "FW" provide 100mm "P" trap floor wastes with riser extended to stainless steel square top stone/tile insert hinged top floor wastes set at a level to suit floor grading. Square top floor wastes shall be OPIE Manufacturing Group SMC Stainless Mett Manufacture Code FW3 Available Tel: 02 4735 5666.

2.13 VINYL FLOOR WASTES

Provide and install SPS manufacture chrome plated, all bronze model LG100 CPA, Push-in Sheet Vinyl Floor Wastes where floor wastes are in areas with vinyl floors excepting where model SS VFW is required by notation on the drawings.

2.14 BASKET TRAP FLOOR WASTES

Provide and install Opie Group SMC Stainless Trade Waste Floor Sump Code AT-5-HST incorporating three part strainer. Where vinyl floor coverings are to be provided, supply floor sump with vinyl clamp ring. Provide under each floor waste a HDPE 'P' trap and HDPE waste pipe.

2.15 CLEAROUTS

Install 100mm diameter brass or stainless steel clear outs at finished floor level as necessary for rodding maintenance of the drainage lines.

Clear outs shall be chrome plated where located internally.

Where vinyl floor sheeting is laid, provide SPS manufacture, 100mm chrome plated brass, push-in sheet vinyl floor clear out.

Clear outs for sub soil drainage shall consist of uPVC DWV grade sewer socket with thread then screw on loose sewer inspection cap terminated 150mm below finished ground level.

Clearouts located in concrete pavement or brick paver shall be terminated flush with finished levels complete with brass or stainless steel, bolted trap screws.

2.16 CAST IRON REFLUX VALVES

Reflux valves shall be of epoxy coated cast iron material.

Cast iron reflux valves are to be located in a pit with gas tight lid with pit size to comply with AS 3500 as required by the hydraulic drawings.

2.17 UPVC REFLUX VLAVES

uPVC reflux valve shall have 150mm diameter riser to surface and be finished with a stainless steel bolted trap screw.

2.18 RAFT SLAB SUPPORTS

All sanitary and trade waste drainage pipelines located on unstable ground shall be fully supported on a continuous reinforced concrete raft suspended from structural slab over, or supported on a sub base certified by a qualified engineer, as required, to the Authorities' requirements all in accordance with AS 3500.

2.19 MANHOLES AND STRUCTURES

Manholes and structures shall be steel reinforced concrete, manufacture and constructed in accordance with approved precast systems to the required dimensions, depth and levels complete with approved ductile covers and frames. Alternate in-situ construction shall be complete with minimum 150mm thickness reinforced concrete and subject to approval from a Structural Engineer.

All pits and structures in paved areas shall be furnished with brass edge strips to allow paving to occur within the cover to match the surrounding finishes.

2.20 TRENCH BASE SUPPORT FOR SEWER, GREASE WASTE AND STORMWATER DRAINAGE

As the general area in which sewer and grease waste drainage is to be installed is filled ground and compaction standard is unknown, comply with the requirements of the Australian Standard AS 3500.2. Department of Fair Trading will require compliance with the Standards through their Plumbing and Drainage Inspector.

To avoid a situation arising where uncompacted trench bases are encountered during installation the following procedures shall be followed and costed.

Procedures would be:

1. Excavate trenches to depths indicated on hydraulic drawings.
2. Engage geotechnical engineer to pot hole and take samples at 3 metre intervals along trench bases. Leave trenches open. Risk of trench side cave in and filling with water is with contractor, therefore incorporate procedural work that will prevent or limit this.
3. Geotechnical engineer to confirm whether "as found" trench base will be capable of withstanding mass of pipe and imposed load of trench refill plus drainage pipe. If acceptable, geotechnical engineer to confirm to Contractor to lay drainage and refill trench after inspection by geotechnical engineer.
   Geotechnical engineer to issue certificates for each trench, which is to be provided to the Department of Fair Trading Inspector by Contractor.
4. Should the trench base not be acceptable to geotechnical engineer further excavate trench base to require depth and backfill depth with selected road base. Compact road base to required invert level of drainage pipes and then repeat the pot holes and laboratory testing as before.

2.21 DRAINAGE PIPES PASSING THROUGH CONCRETE GROUND BEAMS OR SUSPENDED SLAB BEAMS

Where drainage pipes pass through concrete ground beams and concrete suspended slab beams install the pipes after footing trench is dug then provide and install Bradford white polystyrene sectional pipe insulation (telephone Bradford 02 97351480) over the pipe. Insulation shall be 25 mm thickness and shall be provided in two (2) SEMI CIRCULAR HALVES, insulation shall extend 100 mm past concrete waffle pod beams each side. Tape along joints with 75 mm reinforced tape.

2.22 PIT COVERS AND FRAMES

Covers and frames shall be ductile iron, complete with frames set into rebates to conform with finished levels. Covers and grate shall be of adequate local rating to conform to AS 3996 and generally as follows:

Internal Pedestrian Traffic (no travels) -	Class A
Pedestrian-ways -	Class B
Roadways/ car parks -	Class D
Heavy Duty Forklifts & Earthmoving Equipment -	Class E

Provide brass machined edge trim strips to all pits located within paved and tiled areas.

Covers shall be bolt down type where any back pressure / over flow surcharge may occur or where located subject to vehicular traffic.

The alignment of these pits, with respect to the adjacent walls, finishes and patterns shall be fully coordinated on site prior to any installation proceeding.

2.23 GRATING AND FRAMES FOR SUMPS AND GRATED TRENCHES

Gratings shall be complete with frames and shall be hot dip galvanised steel, each grating and frame shall be set flush with the finished surface levels. Grating sizes and type shall be as indicated on the Hydraulics Services drawings. All gratings shall be push bicycle safe type.

Each grate and or section of grating shall be bolted down. All heel grates shall be heel guard type with max openings 13mm x 150mm complying with AS 1428.

2.24 COALESCING PLATE INTERCEPTOR AND ASSOCIATED EQUIPMENT

Supply and install Fox Environmental waste water treatment plant and equipment comprising:

1. FX1000SS-D, 1000L/hr stainless oil separator
2. Fox waste oil reservoir
3. FXP 10000 – Diaphragm Pump

4. Fox X2 control box (240 V 10amp Power Supply)
5. Set of UPVC suction and delivery pipework.
6. Electrical controls including conduits and wiring.
7. Wash down water collection pit high level float switch and flashing alarm light positioned on wall adjacent to plate interceptor.
8. FSK-40 floating skimmer

2.25 CAR WASH BAY HOLDING WELL

Excavate for and install a polyethylene holding tank as located on the Hydraulic Services drawings. The product shall have minimum 1200L capacity and equal to Aline Maxi E series with a Class D access lid.

2.26 LOW LEVEL INDUCT VENTS

Low level induct vents where indicated on the drawings are to be of zincalume sheet metal to the approval of the authority. At the ground surface around each induct vent provide concrete 150 x 150 x 100 deep concrete.

2.27 SEWER OVERFLOW GULLY

Overflow gully shall be installed in the position indicated to provide a safe release of sewage from the connection point. Gully shall be constructed of a 100 mm "P" trap and riser.

Top of riser shall incorporate 75mm above the surrounding surface area. Gully shall be provided with concrete bedding and surround as per AS 3500.

2.28 SEWAGE PUMP STATION

Supply and install an Aquatech or E-one 3000L sewer pump station as detailed on the hydraulic drawings. The SPS shall be 1390mm Dia x 2500mm deep. Provide 900 x 600 two part, 316L grade stainless steel purpose manufactured, light duty, gas sealed covers and frame. Covers to be non-slip type.

All works must be undertaken in accordance with Sydney Water’s requirements.

Provide 15 MPA concrete 1500 high from base surrounding the SPS unit. Fill pump station with water during placement of concrete.

The following shall be provided and installed.

The sewerage station shall be complete with:

- Hazard Control: Pump motor and all the components within the pumps station including all motors, pumps and electrical control panel shall comply with Class 1 Zone 2 requirements so that there is not possibility of a spark.
- Two (2) submersible sewerage grinder pumps.
- Submersible sewerage grinder pumps slide rails.
- One sewerage aerator.
- 50mm discharge pipeline and valves.
- Liquid level controls and alarms.
- 100 diameter uPVC electrical conduit from the pumps electrical control panel to alarm light location, with remote alarm wiring
- Weatherproof flashing alarm light fixed to building in an approved location where shown on hydraulic drawings.
- 316 grade stainless steel electrical control panel fixed to wall of building. Panel shall have blank lockable door on outside with switches and lights on an internal hinged door.
- 25mm diameter bronze solenoid valve with fail closed mechanism. Valve shall be waterproof type. Precede solenoid valve with bronze ball valve. Provide 25mm diameter copper fill pipe from outlet of solenoid valve, terminate over drainage turn up which shall be arranged to drain fresh water into the SPS via a sewer gully.
- Electrical wiring and conduit between pumps electrical control panel and solenoid valve.

- Electrical power and alarm wiring between sewer pumps station and pumps electrical control panel.
- 20mm rain water hose tap adjacent to sewer pump station. Provide backflow prevention device on outlet of hose tap. Also provide sign "Do Not Drink".
- 100mm vent off SPS chamber.
- Data point output.

Sewerage Pumps and Aerator

Provide, install, commission, warrant and maintain for twelve (12) months, the following pumps, aerator and electrical controls:

Engineering Service	Sewer Drainage
Model Sewerage Pumps	
Quantity	Two (2) required
Flow	2 l/s
Head	15m
Motor Rating (kw)	Pump equal to 2.6kw (one pump to run at any time) total 5.2kw, 10.6 amp
Volts	415
Guide Rails	Two (2) required
Liquid Level and Alarm Controls	Four (4) required model KA-MAC3-10M
Electrical Control Panel	As specified
Sewerage Aerator	
Quantity	One (1) required
Aerator Type	1.5kw, 2.4 amp full load current
Electrical Control Panel	As specified

Hazard Control: Pump motors and aerator motor and all components within the pumps electrical control panel shall comply with Class 1 Zone 2 requirements so that there is no possibility of a spark.

Sewerage Pump Station Electrical Control Panel

Requirements are:

- Panel to be IP65.
- Manufacture cabinet from 1.2mm thick 316L grade stainless steel.
- Provide concealed hinges and key locking.
- Provide 15% spare space inside panels for system enlargement.
- Colours of indicator lights shall be Red (fail and alarm), Amber (operating), Green (power available).
- Provide black letter on white background labels, screwed to panel. Lettering shall describe pump set controlled.
- Provide and install electrical power control and alarm wiring within electrical conduits.
- Fix panel to wail in plant room with top 1800mm floor or ground surface.

Electrical Control Panel shall be located remote from the pump assembly installation and complete with:

Description	**Indicator/ Operation**
Power On	Green Light
Sewerage pump 1 On/ Off/ Auto Switch	
Sewerage pump No 1 Run	Amber Light
Sewerage Pump No 1 Fail -(Mechanical Reasons)	Red Light and Remote Alarm

Sewerage Pump No 1 Fail	Reset button
Sewerage Pump No 2 On/Off/Auto Switch	
Sewerage pump No 2 Run	Amber light
Sewerage Pump No 2 Fail -(Mechanical Reasons)	Red Light and Remote Alarm
Sewerage Pump No 2 Fail	Reset button
Sewerage Aerator Run	Amber light
Sewerage Aerator Fail - (Mechanical Reasons)	Red light and Remote Alarm
Sewerage Aerator Fail	Reset button
Sewerage Aerator On/Off Auto Switch	
Sewerage Tank High Level Alarm	Red Flashing light on top of sewera pump station electrical control panel. Al wire to flashing red light in remo location
Sewerage Pump 1 fail - Remote Alarm Cancel (to operate only after alarm)	Red light and remote alarm
Sewerage Pump 2 fail - Remote Alarm Cancel (to operate only after alarm)	Red light and remote alarm
Sewerage Aerator Fail - Remote Alarm Cancel (to operate only after alarm)	Red light and remote alarm
Sewerage Pump Out Well Low Level Alarm Cancel (to operate only after alarm)	
Sewerage Pump 1 - Hour run meter	
Sewerage Pump 2 - Hour run meter	
Aerator - Hour run meter	
Electrical Control Panel Light Bulb Test	Push button
Time Clock activation Pump 1	Time clock will be 24 hour 7 day
Time Clock activation Pump 2	Time clock will be 24 hour 7 day

Other Requirements:

21. Time clock to permit fresh water from solenoid valve to flow into pump station and also close the valve.

22. Transformer 415/240V to 24V for control wiring.

23. Control panel secret on/off switches to deactivate remote fault alarms.

24. Four (4) time clocks are required inside control panel.

25. Audible alarm indicating equipment failure.

26. Alarm mute button.

27. Main isolation switch.

28. Automatic pump cycling.

29. Circuit breakers for each motor and control circuit.

30. Volt free contacts for extension to building monitoring system.

31. All wiring between pumps and control panel.

32. Control panel shall be manufactured from 1.2mm thick, 316L grade sheet stainless steel and have two doors, i.e. inner door with control panel face functions and blank outer door to prevent vandalism. Front hinged door shall be key lockable and dustproof.

Electrical Conduit

Provide 100mm diameter electrical conduit from the SPS control panel to the SPS pumps, aerator and water supply solenoid valve. Provide draw wire within conduits.

Maintenance Manual

In addition to the O&M manuals, provide three bound copies of an operations and maintenance manual with each item of pumping equipment.

Submit a draft copy including folder and binding for consideration by the Principal prior to printing and issue.

Include the following information in the manual:

- Method of switching and operation of control panels and alarms.
- Wiring diagrams for equipment and control panels.
- Recommend maintenance required on pumps and motors.
- Name, address and telephone number of manufacturer of equipment.
- Emergency telephone number for service.
- Spare parts list.
- Pump and motor performance and characteristics.
- Pump and motor construction details.
- Commissioning Record sheets.
- Any other additional items requested by the Principal.

2.29 COMMISSIONING THE SEWER PUMP STATION

Engage council/authority to attend the site and commission the sewerage pump station, electrical controls and alarm system.

2.30 DOWNPIPE CONNECTORS TO STORMATER DRAINAGE

Refer to civil documentation

2.31 WASH DOWN DRAINAGE FLOOR SUMP

Provide and install Fox PT/600 silt trap with Class D grates for all pits within vehicle plant room. Provide with the sumps lift out stainless steel strainer buckets with handle. Strainer buckets to be drilled to standards of Water Authority Trade Waste Division. Also provide to each sump a fixed secondary strainer driller to authority trade waste requirements. Aglass 450 pits are deemed as acceptable alternative products for selection for the wash down sump & pits contained within the ambulance bay.

2.32 PIPE SUPPORT BRACKETS TO PIPES UNDER FLOOR

All pipe support brackets where installed in service trenches under the floor of the building shall be 316 grade stainless steel. This includes the hanging rod.

2.33 RECORDS OF INGROUND DRAINAGE SYSTEMS

During construction submit progressive 'Work as Executed' drawings for all the services specified in this section, showing the locations and depths of pipes and fittings including inspection openings, pits,

inverts of underground services, positions of control valves and the like. Give coordination dimensions where applicable. At the completion of the contract prepare fully detailed 'Work as Executed' drawings and maintenance manual as previously specified.

Accurate set-out dimensions to new or existing buildings must be included, especially where services have been approved on site to be located differently to the design drawings.

2.34 TESTING

Supply all materials necessary for the test and carry out all tests required by the regulatory Authorities.

Do not cover or conceal from view underground or enclosed work until it has been inspected, tested by the Contractor and approved by the Project Manager and the relevant Authority.

Apply the following tests to all stormwater, sanitary, trade waste drainage pipelines;

Water test the system by sealing all openings below the top of the section to be tested and filling the section with water under a head equal to the maximum head which would result from a chokage in the section under test or three (3) times the pump head in the case of rising mains, for a period of twenty four (24) hours,

2.35 ON COMPLETION

Clear and clean the following:

- Pits and in ground structures.
- Bottom of each floor waste 'P' trap.
- Chrome plated floor waste grates, remove grates, clean and grease sides of grates.
- Labels.

SECTION 3 - SANITARY PLUMBING

3.1 EXTENT OF WORK

The work specified in this section comprises the supply installation testing and commissioning of the soil, waste, vent pipes and rainwater/overflow downpipes including all bends, offsets, branches, brackets and other items necessary to complete the installation.

The work shall commence from the point of connection to the drainage systems, and shall be carried out as hereunder scheduled and to the satisfaction of the Authorities.

3.2 MATERIAL SCHEDULE

Pipes and fittings shall be in materials as follows:

Service	Size	Material
Soil wastes and vents	40-100	Sewer grade uPVC, DWV
Rainwater and overflow downpipes	100,150	Sewer grade uPVC, DWV/Colorbond

3.3 P.V.C. PIPES AND FITTINGS

P.V.C. pipes and fittings shall be approved manufacture "DVW" Class comply with AS 1260.

Pipes and fittings shall be jointed by using approved solvent welded joints.

All workmanship and materials used shall comply with all local conditions and regulations imposed and/or required by the local Authorities having jurisdiction.

3.4 PIPE GRADIENTS

Soil and waste pipes shall be installed at the minimum gradients approved by the Australian Standard. Pipes are not to be oversized to reduce grade.

3.5 FIRE STOP COLLARS FOR UPVC AND OTHER PLASTIC PIPES

Wherever uPVC pipes or other plastic pipes are installed through fire rated floor and or walls, then provide at each position a Promat manufacture Hi-Blu or equivalent providing for 2 hour rating.

Where pipes pass through existing concrete floor slabs and fire rated walls then fire stop collars shall be retrofit type.

3.6 INSPECTION OPENINGS AND SCREWED CAPS

Install inspection openings in pipes so that each section of pipework is accessible in at least one (1) direction.

150 and 100mm diameter horizontal pipework: One (1) inspection screw cap square junction every twelve (12) metre length or where total length is less than twelve (12) metres, provision of one (1) inspection screw cap square junction. Downpipe testing inspections: Install 100mm diameter testing screw cap square junction at the foot of each downpipe. Foot shall have the meaning, just above turn out from vertical downpipe to either underground drainage or turn out from vertical downpipe to horizontal suspended stormwater drainage.

Downpipe access inspection: Provide as part of each main junction connection point in vertical downpipes a 100mm access inspection. Generally this gate will be at high level each floor. The high level 100mm access gate shall be provided in a position to give rodding access into pipes within false ceiling spaces from the downpipe position. In addition a 100mm access inspection shall be provided at each second floor level of the building approximately 400mm centre line above floor level. This low level inspection shall be used to place testing plug.

3.7 VENT PIPE TERMINATIONS

All vents passing through roofs shall be fitted with neoprene rubber waterproof seal. The flashings shall be clamped to the pipe with a stainless steel band and fixed to the roofing material with a zincalume steel plate.

All exposed vents shall be uPVC, provided with a cowl and painted to the architect's requirements.

3.8 ACCEPTANCE AND RESPONSIBILITY OF SANITARY FIXTURES

The Contractor shall allow to take receipt of all sanitary fixtures when delivered to site by the manufacturer. Co-ordinate this operation with the Project Manager.

On receiving the goods be totally responsible for their numbers and condition until the completion of the project.

3.9 ACOUSTIC INSULATION FOR SANITARY PLUMBING AND RAINWATER DOWNPIPES PIPEWORK

Supply and install Thermotec NuWrap 5™ Pipe & Duct Insulation / Sound Lagging acoustic pipe insulation in preformed sections or flat sheets formed to shape. All pipework located above or within living areas and/or bedrooms require the application of Thermotec NuWrap 5™ unless otherwise noted.

Acoustic Insulation shall be applied to the manufacturer's specification. The minimum overlap of the pressure sensitive reinforced aluminium foil tape is 50mm. The Acoustic Insulation shall be fitted as a one piece preformed section or where required flat sheets cut to size and wrapped completely around fittings and sealed with pressure sensitive reinforced aluminium foil tape with a minimum width of 75mm.

3.10 FIXTURE TRAPS. PLUG AND WASHERS

Wherever possible fixtures shall have integral traps. Concealed traps shall be polypropylene, universal "S" or "P" type and have self-cleaning characteristics, and be of the same size as the outlet of the fitting. Fixture traps shall have a 75mm deep seal.

Basin traps shall be 40 diameter chrome plated copper bottle trap with 40 waste pipe in wall. All plug and washers installed in basins shall be chrome plated brass.

Wash trough and drinking trough, traps and waste pipes shall be 50mm diameter chrome plated copper, "P" trap with waste pipe concealed in wall. All plug and washers installed in wash troughs and drinking troughs shall be chrome plated brass.

All waste pipes concealed within brickwork or concrete shall be insulated with expanded vinyl equal to Kemlag. Over-wrap all joints to approval.

3.11 FLOOR TUNDISHES

Where indicated on the drawings provide and install Opie Group (formerly SMC Stainless) floor mounted tundish manufactured from 316 Grade Stainless Steel, model TURE1A.

3.12 RECESSED TUNDISHES

Where indicated on the drawings provide and install Opie Group (formerly SMC Stainless) recessed in wall tundish manufactured from 316 Grade Stainless Steel, model FMT7 (152x96)

3.13 FLOOR WASTES

Floor wastes shall comprise 100 diameter gullies, complete with chrome plated brass grate set at a level to ensure correct drainage of floor areas. 80mm diameter floor waste risers are not acceptable.

Provide uPVC puddle flange at floor level to receive membrane.

Provide and install 100 mm diameter chrome plated brass square push in floor waste unless nominated by the architect.

3.14 VINYL FLOOR WASTE (VFW)

Provide and install SPS manufacture chrome plated, all bronze model LG100 CPA, Push-in sheet vinyl floor wastes where floor wastes are in areas with vinyl floors excepting where Model SS VFW is required by notation on the drawings.

3.15 BASKET TRAP FLOOR WASTES

Provide and install Opie Group SMC Stainless Trade Waste Floor Sump Code AT-5-HST incorporating three part strainer. Where vinyl floor coverings are to be provided, supply floor sump with vinyl clamp ring. Provide under each floor waste a HDPE 'P' trap and HDPE waste pipe.

3.16 TESTING

On completion all work shall be hydrostatically tested under expected maximum choke conditions for a period of two (2) hours. Any defects shall be remedied and the test reapplied. Provide all testing gates and apparatus necessary for the test.

3.17 ON COMPLETION

On completion flush and remove all debris within the systems, remove all external labels and polish all chrome plated finish to remove any marks.

Clear all drainage lines with suitable automatic drain cleaning machine to ensure blockages will not occur prior or during the twelve (12) months warranty period.

Maintain the entire plumbing system during twelve (12) months warranty period including attendances should problems arise through blockages in the piping system.

SECTION 4 - WATER SERVICES

4.1 EXTENT OF WORK

The work specified in this section comprises supply, installation, testing and commissioning of the potable cold water services, potable hot and warm water services. Work also includes the installation of a fire hydrant system including brigade booster assemblies.

Work also includes rainwater pressure pumps, electrical control panel, power and control wiring and rainwater reuse distribution pipeline.

4.2 MATERIAL SCHEDULE

Service	Size	Material
Potable Cold-Water Service	As indicated on the drawings 20-50mm	Large water mains Underground - PE pipe with blue stripe PN 16 with electrofusion fittings. Provide coloured detectable marker tape over with words Potable Cold Water Service tape to have copper wire bound within Small Water Services Underground - Type "B" copper tube, silver brazed joints. Pipework to be within blue poly bag. Above Ground - Type "B" copper tube, silver brazed joints/press fit
Potable Cold, Hot and Warm Water Service including hot water flow and return pipes	15 - 40mm	Copper Pipe. Insulate all hot and warm water pipes where not within walls with 32mm Thermotec 4 Zero sectional insulation. This includes all non-circulating hot and warm water pipe runs.
Potable Cold, Hot and Warm Water Service Branches in Masonry Walls	15 - 100	Green plastic covered Kemlag Copper Pipe
Potable cold, hot, warm water services branches in dry walls	16-25	Rehau cross linked polyethylene pipe with non-metallic fittings.
Exposed Water Pipes	15 - 25	Chrome plated copper tube and fittings

Bolts and nuts used underground and above ground shall be 316 grade stainless steel.

Flanges required underground shall be 316 grade stainless steel.

Metal backing flanges behind polyethylene electrofusion stub flanges required underground shall be 316 grade stainless steel.

4.3 CONNECTION TO EXISTING WATERMAIN

The Contractor shall allow to locate, excavate over, and connect to the existing main and backfill, to the satisfaction of Local Council/Authority and the Project Manager. Pay all fees to Council and NSW Department of Fair Trading.

4.4 ACCEPTANCE AND RESPONSIBILITY OF TAPS AND WATER OUTLETS

The Contractor shall allow to take receipt of all taps and water outlets when delivered to the site.

Co-ordinate this work with the Project Manager.

4.5 COPPER PIPES AND FITTINGS

Pipework

Shall be installed in a neat workmanlike manner and shall include all necessary sets and be complete with sufficient unions, flanges and isolating valves for satisfactory removal of piping and fittings for maintenance or repairs, whether or not such items are shown on the drawings or specified.

In addition to general provisions for installation of copper pipe, pipes shall be fixed in continuous lengths wherever practicable and bent at changes of direction in preference to using fittings.

Copper Tube

Shall conform to Australian Standard AS 1432 Type B.

Joints

Braze copper and brass with silver brazing alloy containing not less than 5% silver. Use oxy-acetylene heating for all brazing.

Fittings

Manufactured fittings shall be of approved type either dezincification resistant brass or correctly formed large radius copper bends with long socketed enlargements.

Where branches of smaller size from main pipe occur, "T" joints shall be drilled, softened and flared to form a slip joint.

Flushing

Water mains and water services shall be flushed as thoroughly as possible with the water pressure and outlets available. Flushing shall be done after the pressure test has been carried out.

4.6 CROSS LINKED HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS (PE-X)

Requirements: Cross linked polyethylene pipe and fittings (PE-X) for hot and cold water systems, shall be first quality and in accordance with AS 2492.

Water Services Pipes:	PN 20 complying with AS 3500.1 PE-X pipes shall be one pipe size larger than the equivalent copper pipe size.
Fittings:	Rehau plastic fitting range and fittings manufactured of Brass which are Dezincification Resistant to AS 3688.
Jointing Method:	As per manufacturer's instructions.
Prohibited Areas of installation:	Cross Linked Polyethylene will not be used in areas as specified in AS 3500.1
Colour of Pipes:	Cold drinking water - silver Hot and warm drinking water - Red Rainwater reuse - green Recycled water - purple

4.7 PRIVATE WATER METER

Purchase and install a 32mm diameter council/authority approved water meter to record all water used in the new building. Provide bronze unions each side of water meter.

Stainless steel chain open the ball valve and provide 50mm wide brass Lockwood padlock with 003 key. Give two keys to project manager.

4.8 AIR RELIEF VALVES

Air relief valves shall be Spirax Sarco telephone (02) 9621 4100 model AE 30. Connect to pipelines where indicated with 15mm ball valve and extend 15mm pipeline from 8 mm connection on valve to drain.

4.9 REDUCED PRESSURE ZONE DEVICES. VALVE CONTROL GROUPS -RPZD/VCG

Reduced pressure zone assemblies (RPZ) shall be ValvCheq RP03 manufacture, complete with:

- Stainless steel in wall box with Perspex lockable front panel.
- Two RPZD valves inside box cold 20mm and hot 20mm with ball valves, strainers and unions each side of each RPZD.
- 50mm drain in wall connected to floor waste.
- Screw fixed signage on cover of box:
- "These valves require regular service by a qualified tradesperson"
- Metal disc with valve number engraved fixed to inside box on back wall.

Available through Flotech Solutions Tel: (02) 4572 0974.

Test and certify all RPZD installations.

4.10 TEMPERING VALVES

Tempering valves shall be Caleffi manufacture.

4.11 PIPE FIXING THROUGH STEEL WALL FRAMING

Where pipe work is inserted through holes in steel wall framing, provide proprietary rubber grommets to isolate pipe from steel to prevent vibration noise and corrosion.

4.12 ADJUSTABLE PRESSURE REDUCING VALVE

Adjustable pressure reducing valves shall be:

- Caleffi 535 series, bronze, spring adjustable pressure reducing valve. Set outlet water pressure to 500kPa.
- Screwed 20 to 50mm.
- Provide screwed bronze union each side of screwed pressure reducing valves.

4.13 HOT WATER TEMPERATURE

All sanitary fixtures delivering hot water shall be in accordance with AS 3500 Part 4 clause 1.9 and shall not exceed 50°C (residential buildings) at the outlet of all sanitary fixtures used primarily for personal hygiene purposes (i.e. bathrooms, ensuites, showers and hand washing.)

Hot water to kitchens and laundry other than personal hygiene fixtures shall be fed directly from the hot water source.

4.14 HOT WATER STORAGE TANKS

Supply and install where shown on the drawings one (1) 315L Rheem electric storage hot water unit with 4.8kW element.

- Pipework connections, ball valves, check valves, pressure relief valve, copper relief drain to DTU and unions at each pipe connection.
- Relief drain terminated 25mm above drainage turn-up or 100mm above ground if outside the building.
- TP & R valve fitted and checked for correct operation.
- Pressure Limiting Valve on cold water supply when water pressure is over 500 kPa.
- Copper safe tray manufactured from 0.5mm copper sheet and with joints soft soldered. Fold upper edge of sides to form safety edge. Provide 50mm drain outlet in one corner discharging over drainage turn-up.
- A "Baytak" manufacture polypropylene heater base of the type and appropriate diameter for the diameter of heater cylinder positioned under each heater and within safe tray.

4.15 HOT WATER CIRCULATION PUMP SET

Requirements are:

- Locate on Kelair galvanized steel wall frame adjacent to hot water heater.
- Provide pumps constructed of materials and with flow and head characteristics as described in the pump schedule.
- 100mm dial face pressure gauge to be provided on suction and delivery pipework to each pump. Provide ball valve preceding each gauge.
- 100mm dial face temperature gauge to be provided on delivery pipework of pump set.
- Arrange pipework in "Z" configuration to receive temperature gauge element.
- Provide TA bronze stad valve to regulate flow on discharge of each pump.
- Provide bronze swing check valve on outlet of each pump.
- Provide bronze ball valve on suction of each pump.
- Provide stainless steel braided hose vibration eliminators on suction and discharge of each pump.

1. Hot Water Circulation Pump Set

Provide, install, balance, commission, warrant and maintain for twelve (12) months, the following pump sets and electrical controls.

Engineering Service	Hot Water Circulation
Pump Set	
Model	Kelair/Grundfos UPS 32 - 80B
Quantity	Two (2) required
Flow	0.3 l/s
Head	3m
Motor Rating (kW) Volts	240
Pressure Gauge	100mm diameter dial face
Temperature Gauge	100mm diameter dial face
Pipework	Type B Copper Tube AS 1432
Pump Frame Support	Galvanised Mild Steel
Electrical Control Panel	As specified in other clause

2. Hot Water Circulation Pump Set Electrical Control Panel

Requirements are:

- Panel to be IP54.
- Manufacture cabinet from 1,2mm zinc coated sheet metal.
- Provide concealed hinged and key locking.

- Provide 15% spare space inside panels for system enlargement.
- Colour of indicator light shall be Red (fail and alarm) Amber (operating), Green (power available).
- Provide black letter on white background labels, screwed to panel. Lettering shall describe pump set controlled.
- Spray paint panel with metal primer and two (2) coats of finishing paint.
- Provide and install electrical power control and alarm wiring within electrical conduits.
- Fix panel to wall with top 1800mm floor or ground surface.

Electrical Control Panel shall be manufactured by Kelair Pumps, located above the pump assembly installation and complete with:

Description	**Indicator/ operation**
Power On	Green light
Hot Water Return Pump 1 Run	Amber light
Hot Water Return Pump 1 Fail	(Mechanical Reasons) Red light and remote alarm
Hot Water Return Pump 1 Fail	Reset
Hot Water Return Pump 2 Run	Amber light
Hot Water return Pump 2 Fail	(Mechanical Reasons) Red light and remote alarm
Hot Water Return Pump 2 Fail	Reset
Hot Water Return Pump 1	On/Off Auto Switch
Hot Water Return Pump 2	On/Off Auto Switch
Hot Water Return Pump 1 Fail	Remote Alarm Cancel
Hot Water Return Pump 2 Fail	Remote Alarm Cancel
Hot Water Return Pump 1 - Hour Run Meter Record	through BMS
Hot Water Return Pump 2 - Hour Run Meter Record	through BMS
Electrical Control Panel Light Bulb Test	Push Button
Alternation of Hot Water Return Pumps 1 and 2 on 24 hour sequence	
Transformer 415/240V to 24V for Control Wiring	
Hot Water Return Pump 1 Fail - (Mechanical Reasons)	
Hot Water Return Pump 2 Fail - (Mechanical Reasons)	
Hot Water Return Pump 1 - Hour Run Meter	
Hot Water Return Pump 2 - Hour Run Meter	

Provide inside the pump control panel a HPM 24 hour adjustable electrical timer. The timer shall be capable of locking out one whole day of pump operation should the client so select.

4.16 WATER HEATERS - MAINS PRESSURE. ELECTRIC

Mains pressure electric water heater shall be complete with:

4.17 THERMOSTATIC MIXING VALVES / VALVE CONTROL GROUPS (TMV/VCG)

Thermostatic mixing valves (TMV) shall be Enware manufacture complete with:

- Enware 4 and 5 point Aqua Blend 1500 valve control group TMV/VCG as detailed on the drawings.
- Special stainless steel box enclosure with hinged lockable cover and frame.
- Box cover epoxy paint coated by Enware to colour selected by Architect from the Dulux colour range.
- Provide screw fixed signage on cover of box, "Thermostatic Mixing Valve, this valve requires regular servicing by a qualified tradesperson". Submit sample for approval.
- Metal disc with valve number engraved and fixed to inside box on back wall.
- As the boxes are approx. 70mm deep then cut brickwork with masonry chasing machine to this depth.

4.18 FLUSHSAVER URINAL INWALL BOXES

FlushSaver Urinal in-wall boxes shall be manufactured and supplied complete (in parts)

- Special stainless steel box enclosure with key. All boxes keyed alike.
- Face plate epoxy paint coated to colour selected by Architect from Dulux colour range.
- Boxes will be 70mm deep and cut into the brickwork with masonry chasing machine to this depth to entirely recess the boxes.

Urinal FlushSaver Box Sets are available from Water Conservation Services International – Tel (02) 9971 1014 - Fax (02) 9971 6858 - email watercon@optusnet.com.au - or phone Roger 0408 677978 for further information.

Install single or double FlushSaver Box Sets in locations indicated on the drawings.

FlushSaver Urinal Box Set - Single. - Code FU-BS-S

COMPONENTS:

1 x Urinal sensor/control module

1 x 13mm Burkert Solenoid Valve

1 x set figure eight cable

1 x 13mm air gap valve

1 x 24V power adaptor

1 x plastic box to hold sensor

1 x in-wall stainless steel in wall storage box - face plate colour as selected by Architect from

Dulux range of colours.

FlushSaver Urinal Box Set - Double. - Code FU-BS-D

COMPONENTS:

1 x Urinal sensor/control module

2 x 13mm Burkert Solenoid Valve

2 x sets of figure eight cable

2 x 13mm air gap valve

1 x 24V power adaptor

1 x plastic box to hold sensor

2 x in-wall stainless steel in wall storage box - face plate colour as selected by Architect from

Dulux range of colours.

Provide and install purpose made stainless steel angle brackets with stainless steel expansion wall fastening and nuts and bolts to fix the plastic boxes containing sensors to Wall.

Single Box Sets shall contain one single 240V GPO (installed by the Electrician) attached vertically to the internal side wall of the in-wall box.

Double Box Sets shall contain one single 240V GPO (installed by the Electrician) attached vertically to the internal side wall of the in-wall box - can be installed in either box.

After commissioning give keys to the Property Manager on site.

4.19 ELECTRICAL CONDUITS AND WATER LEVEL SENSORS

Provide and install orange uPVC electrical conduit from fire hydrant pumps electrical control panels, underground, externally to tanks and internally to tanks. All conduit brackets external to tank shall be hot dip galvanized steel. Bracket internal of tanks shall be 316 grade stainless steel.

Provide and install in each tank Kelair low water level pump stop water level switch. All water level switches and electrical wiring shall be 24 volts type.

4.20 FLEXIBLE BRAIDED WATER CONNECTIONS

Braided connection (Plumb-easy or similar) shall not be used in hot water unit installations service ducts or plantrooms. They may be used in ablution areas where 100mm floor wastes are provided and, if they fail, no real damage is caused. Where they are used they shall be of the correct type to prevent straining, kinking or twisting or stresses on the connections. They shall be correct length to match the installation requirements.

4.21 WATER CONNECTIONS TO BASINS AND SINKS

Provide and install 15mm BSP brass male thread at the wall for both cold and hot water points.

Provide and install chromium plated cover plate at wall for cold and hot water points.

Provide and install approved stainless steel braided flexible connector, "Aquaconnect" or equal.

Cold and hot water connections to wall basins shall be carried out with annealed, 15mm diameter, chromium plated Type B copper tube. Join the tube to fitting threads at the wall and at the tap sets complete with chromium plated brass Kinco nuts and formed Kinco Knurl ("olives" connection shall not be used)

4.22 COVER DOMES

Provide cover domes to all water services connection where horizontal connections are made at wall and cupboard surfaces.

Cover domes are to be a close fit around the pipe of which they surround, and close against the wall or floor and be chrome plated.

4.23 INSULATION

Insulate pipe works generally as detailed hereunder.

All hot water piping concealed in ducts and ceilings spaces shall be insulated with 32mm thickness Thermotec 4 Zero type sectional lagging incorporating aluminium foil wrap and overlap secured as below and to approval.

All cold water, hot water and warm water piping concealed in brickwork and or blockwork shall be insulated with expanded vinyl equal to "Kembla" or "Crane" Prelag. Over wrap all joints to approval.

Prior to application of insulation materials, all surfaces shall be thoroughly cleaned to remove scale, grease, oil, dirt and any other foreign matter, and where subject to condensation shall be protected against corrosion. All insulation material shall be of best quality in their respective types.

Irrespective of the method of attachment, all insulating materials shall be in close contact with the surfaces to which they are applied. Where performed sectional insulation is used, the edges and ends of sections shall be arranged to butt up close to one another over the whole insulated surface.

Edges or ends of section shall be cut or shaped at site where necessary.

Pre-formed sections shall be complete with a sisal covering connected to the entire external surface.

The covering shall be installed to provide a lap of not less than 25mm at all longitudinal and circumferential joints. The insulation thus applied shall be further secured with bands of noncorrosive metal. Metal bands shall be not less than 19mm wide, installed generally on 450mm centres and at all points where insulation has been cut or shaped.

At flanges, valves and other similar connections, the insulation shall be bevelled and cut back to provide adequate access to bolts and fittings. Valves, flanges and unions, are not required to be insulated.

No insulation shall be applied prior to pressure testing of the respective parts of the installation.

Insulation shall be applied in an approved manner.

Approved wood blocks, the same external diameter as the insulation material shall be provided at all bracket points. The blocks shall be in two halves and shall be a minimum of 25mm wide.

4.24 EXTERNAL HOSE TAPS

Provide and install Type B copper tube extended to hose tap points.

Depth of pipe work shall be 300mm minimum below finished levels.

Hose taps shall be Cimberio lever handle hose taps Code CIM 34 available from All Valve Industries Tel 9558 9911.

Support each hose tap standpipe by securing brass back plate elbow to 100 x 50mm treated pine post concreted (minimum 150mm concrete base and surround) into the ground behind each hose tap. Secure each back plate elbow to post with three (3) round head brass screws, 25mm in length.

Supply and fix with brass screws adjacent to recycled water hose taps, an approved sign with the words "Not Suitable For Drinking" and in accordance with Authorities requirements.

Where hose taps are shown on the drawings to be fixed to external walls, provide brass back plate elbow and secure with three (3) stainless steel screws into expansion fastenings.

4.25 UNDERGROUND PIPE WARNING TAPE

Plastic warning tape 100mm wide shall be laid above all underground water service pipes. Tape be colour to comply with AS 1345 printed with the appropriate water service words. Tape shall contain copper wire fixed each end at ground surface.

4.26 LINE MARKING FIXING BLOCKS AND IDENTIFICATION PLATES FOR UNDERGROUND PIPE WORK SERVICES

Provide and install Line Marking Fixing Blocks and Identification Plates for Underground Cold Water pipe work. Different identification plates shall be provided for each water service. Plates shall be 100mm x 100mm x 3mm thick stainless steel screw fixed to concrete with stainless steel expansion fastenings. Engrave details onto plates.

4.27 PIPEWORK PROTECTION FOR POTABLE WATER SERVICES

Install all external, inground copper pipework in polyethylene blue sleeve protection bag conforming to AS 3680 with joints lapped 600mm and tape sealed.

4.28 ROOM OR GROUP CONTROL RECESSED STOP TAPS FOR COLD. HOT AND WARM WATER SERVICES

Provide ENWARE manufacture Code VP 356 brass key operated, full way recess stop taps with chrome plated internally threaded and colour coded screw off cover dome without any spindle hole.

Install the VP 356 recess stop taps in cold, hot and warm water branch pipelines side by side and 150mm apart in accordance with the detail drawing.

4.29 VALVES

All valves shall be have "Standards Mark" certified to the relevant Australian Standard and compliant to MP52 Specification.

All valves installed in hot water or heating water systems shall be bronze for all pipe sizes.

Valves up to and including 80mm diameter shall be all bronze. Valves 150mm or over may be cast iron with bronze trim, excepting when installed in hot water or heating water pipelines, in which case they shall be 100% bronze or stainless steel.

Valves to pump connections, main branch lines and outlet positions shall be butterfly type.

Valves shall be tested to a pressure of 2,100 kPa by an approved testing Authority.

A. FLANGED VALVES: Valves 55mm and over shall be flanged. All other valves shall be screwed complete with union connection located on the outlet side of the valve.

B. BALANCING VALVES shall be "Tour and Anderson" manufacture "STAD" type screwed up to 50mm in diameter and "STAF" type flanged 55mm and larger diameter.

Above ground valves shall be complete with hand wheel unless they are lever operated ball valves or butterfly valves.

C. BRONZE SCREWED BALL VALVES: Valves 10mm up to and including 50mm shall be either:

Pegler Beacon Australia Fig No. 350G, 350DR, 353DK.

All Valve Industries CIMBERIO Fig No. 11-CR 10mm to 50mm.

Austral Engineering ISIS DZR 10mm to 80mm.

Valves to be brass construction approved for use with hot and cold water supply systems.

D. BUTTERFLY VALVES shall be either:

All Valve Industries Keystone cast iron butterfly valves, wafer style to suit Table

"E" flanges.

Austral Engineering Valve Butterfly Valves Fig 725 Wafer Style or 755 Lugged design, working pressure 15 bar, AS 2129 Table E, disc, 315 stainless steel, one piece shaft, square disc drive with no locating bolts on taper pins. Components of these valves shall be manufactured from the following materials:

Body - Cast Iron

Shaft - Chrome and stainless steel

Disc - Cupro - Aluminium

Liner - E.P.D.M.

E. BRONZE SCREWED GATE VALVES: Bronze screwed gate valves for valves up to 50mm in diameter shall be either:

Pegler Beacon Australia Fig No. 1070M DZR brass gate valves, 10mm to 100mm

screwed.

Austral Engineering Toyo tested AS 1528-1999 Gate and Check valves, 15mm to 100mm screwed.

F. BRONZE FLANGED GATE VALVES: Bronze flanged gate valves for valves from 65mm to 100mm in diameter shall be either:

Pegler Beacon Australia Fig No. 1035E.

Austral Engineering Braemar Fig No. T60M

G. GLOBE VALVES: Bronze screwed globe valves for valves up to 50mm in diameter shall be either:

Pegler Beacon Australia Fig No. 5, GL-5BSP

Austral Engineering Fig No. RHB-3 screwed bronze globe valves 10mm to 50mm.

H. CAST IRON FLANGED GATE VALVES: Cast iron flanged gate valves for 100mm diameter and above shall be local water authority approved.

I. UNDERGROUND VALVES: 100 diameter and above shall be local water authority approved "Sluice Valves" to AS 2638 Class 21, flanged Table F. Provide 150mm diameter UPVC pipe as riser to ground surface with hinged cast iron (SV) path box and concrete surround.

J. CHECK VALVES: Bronze screwed swing check valves for valve up to 40mm in diameter shall be either:

All Valve Industries 15mm to 80mm

Austral Engineering Fig No. C236A 15mm to 80mm screwed.

Check valves on outlet connections to all pumps to be "Mission Duo" check II. Water check: Valves style C, Fig G, 15 BMF, Bronze Alloy 952 body with Vulcanized Buna 'N' seal.

Bronze flanged wafer check valves for valves 50mm and above shall be Austral Engineering Fig No. 301E 50mm to 300mm.

With the exception of loose jumper type valves, spindles shall be non-rising type and must not project into the bore of the valve when the valve is in the fully open position. The bore shall be clear and unobstructed when in this position.

Underground loose jumper type valves shall be path taps, which shall have the bonnet locked into position with the valve body with a bronze set screw. Provide 100 diameter UPVC pipe as riser to ground surface with hinged cast iron (W) path box and concrete surround.

Prior to practical completion provide to the Superintendent valve keys, suitable for each kind of valve spindle head installed underground inside valve surface boxes.

Each valve key shall consist of a socket suitable to fit over the spindle head, a length of steel rod or pipe and Tee handle.

Valve keys shall be hot dip galvanised.

The internal seats and washers of the valves must be cleaned of all foreign material during installation. Any valve faces or seats found damaged on completion of the installation shall be replaced.

4.30 FLANGES AND UNIONS

Disconnecting unions shall be utilized to connect pipework up to 50mm diameter and flanges are to be utilized to connect pipework (50mm diameter and larger) to items of valves, plant and equipment, so all plant and valves can be easily removed and maintained.

Flanges shall confirm with AS 2129. Use brass or bronze brazing flanges for copper tubing. All flanges provided as mating flanges to valves where water pressure exceeds 1000 kPa shall be Table E.

Cop-A-Mate flanges with loose painted steel flanged backing ring are not considered to be equal to bronze brazing flanges and will not be accepted for this project.

4.31 PRESSURE GAUGES

Gauges shall be K.D.G. type except where otherwise noted on the drawings. The faces on the gauges shall be 100 mm diameter. Gauges shall be graduated in metres head and kilo Pascal.

Gauges shall register one-third kPa more than the maximum possible pressure obtainable from the system served.

Each gauge shall be complete with bronze ball valve and sufficient copper piping for connection to the pipe work.

4.32 PRESSURE SWITCHES AND ALARM HOOTERS

Provide all electrical wiring within PVC conduits from pumps electrical control panels to pressure switches shown on the drawings.

4.33 DIAL TYPE TEMPERATURES THERMOMETERS

Thermometers indicating temperature shall be dial type, manufactured by DOBBIE, each with dial face 100mm diameter shall be model V541 direct reading, stern mounted bottom entry type.

The thermometer probe shall be installed into mounting tube of copper pipe a minimum dimension of 150mm long and to a suitable diameter.

Dial type thermometers shall be fitted in the following locations:

- The discharge side of all hot water and warm water return pumps.
- The discharge pipe from a group of hot water heaters.
- On hot water and warm water return headers.

4.34 AIR RELIEF VALVES

Air relief valves shall be Spirax telephone (02) 9621 4100 model AE 30. Connect to pipelines where indicated with 15mm ball valve and extend 15mm pipeline from 8 mm connection on valve to drain.

4.35 STRAINERS

Strainers shall be RMC LS50, LS75 or LSI 00 with 60mm stainless steel gauze.

Plantrooms: Strainers shall be 'Spirax Sarco' bronze bodied on all lines up to and including 50mm and Cast Iron above 50mm with easily removed perforated stainless steel strainer having perforations 0.4mm maximum.

4.36 PATH BOXES

Valves located below ground shall be supplied with cast iron path boxes complete with hinged lid to allow for later access and clearly marked for their respective service type complete with 150mm PVC riser conduit from valve spindle and bedded in minimum 150mm concrete base and surround to finish flush with finished ground or paving level. Maintain 75mm minimum clearance between the top of the valve spindle and the underside of the lid of the box.

4.37 REDUCED PRESSURE ZONE DEVICES. VALVE CONTROL GROUPS - RPZD/VCG

Reduced pressure zone assemblies (RPZ) shall be Tyco manufacture, complete with:

- Stainless steel inwall box width 500mm height 630mm depth 90mm with Perspex lockable cover.
- Two RPZD valves inside box cold 20mm and hot 20mm with ball valves and unions each side of each RPZD.
- 50mm drain in wall connected to floor waste.
- Screw fixed signage on cover of box:
- "These valves require regular service by a qualified tradesperson"
- Metal disc with valve number engraved fixed to inside box on back wall.

Test and certify all RPZD installations. Available Tel: (02) 4572 0974.

4.38 RECESSED VALVE BOX FOR CONCEALED HOSE TAP AND GAS BAYONET VALVE

Provide and install specially manufactured key lockable recessed valve box, by Stainless Metal Craft, product code GVC-IR. Refer detail drawing.

Provide within each box a 20mm star head, quarter turn hose tap and a pillar type gas bayonet valve.

Essential Ensure the entire inside of box is gas and air tight.

4.39 STERILISATION OF WATER SERVICES

Disinfect pipe work installation in accordance with AS 3500 before practical completion. All storage tanks and pipelines shall be flushed clean then with disinfectant using 50mg of chlorine per litre of water. The system should remain charged for a period of at least three days, checked and adjusted for free residual chorine and flushed out thoroughly with clean water before being used. Repeat procedure where necessary.

4.40 CLEANING AND TESTING OF PIPEWORK

All cleaning and testing of pipework shall be carried out as early as possible after testing of each section of the piping and before any points are concealed, ceilings installed, or finishing trades have commenced their work.

All services pipework shall be thoroughly washed out and the system operated with a full flow of water until all foreign matter is removed. Temporary conditions to supply and drain shall be carried out as required and all equipment shall be bypassed during the cleaning and testing period.

4.41 TESTING

On completion, all pipework shall be subject to a pressure test of 2,100 kPa for a period of twenty four (24) hours. Any defects found in the system shall be remedied and the test reapplied. Disconnect pipes from mechanical and hydraulic equipment prior to testing and reconnect on completion.

SECTION 5 - FIRE EXTINGUISHERS AND FIRE BLANKETS

5.1 GENERAL

This section of the specification provides for the supply and installation of hand held fire extinguishers and fire blankets and located in accordance with AS 2444.

All fire extinguishers shall be fully charged at date of handing over.

All fire extinguishers and fire blankets shall be complete with appropriate mounting brackets, horns, nozzles, operating instructions and location signs as per AS 2444 as amended.

Supply and install necessary fire extinguishers and fire blankets in accordance with authority and standards requirements.

All fire extinguishers and fire blankets to be maintained to AS 1851.

Fire extinguishers shall be manufactured in accordance with AS 1841.

Fire blankets shall be manufactured in accordance with AS 3504.

SECTION 6 - SANITARYWARE, APPLIANCES AND TAPWARE SCHEDULE

6.1 EXTENT OF WORK

The work specified in this section comprises the ordering, storing on site and installation of sanitary ware, appliances, Tapware fittings as detailed in the fixture schedule and necessary for complete installation.

All items shall be new and of first quality, free of defects and shall be subject to inspection prior to installation. Such inspection shall not relieve the Contractor of responsibility to ensure all items are free of defects at Occupation Certificate.

Prior to placing order provide samples and obtain guarantees from the manufacture that any items which craze or show any other defects within twelve months of issue of Occupation certificate will be replaced providing that such crazing or other detects are not caused by abuse or inappropriate use of the item.

Fixtures

Fix and support fixtures strictly to respective manufacturer's recommendations.

Tapware and Outlets

Store all taps and outlet fittings and be responsible for fixing of same to the fixtures and appliances nominated and connect same to the water service. All exposed pipework including fixture traps to be chrome plated finish.

Tapware Indication Colours

Cold water taps - Blue

Hot water taps - Red

Warm water taps - Yellow

Refer to architectural FF&E schedule for sanitary fixtures and tapware selection.

6.2 ITEMS RELATING TO SANITARY FIXTURES AND TAPWARE PURCHASE AND INSTALLATION

Provide and install 350 kPa pressure limiting valve within cupboards on cold water supply to boiling and chilled water units.

Provide and install on the outlets of dish drawer and dishwashers machine right angle stop taps a CP brass Nylex Flomasta Flood Stop Safety Valve available from Nylex telephone 1800 338 105.

Provide CP right angle stop taps (mini type) at rough in point preceding connection to lever mixer taps. Taps, water and gas outlets and other fittings shall be bright chromium plated. Mattsson single lever mixer taps shall be of the following models:

- Single bowl sinks and tubs Model 4LOO, 150mm long spout.
- Double bowl sinks Model 4L00, 240mm long spout.
- Basins Model 4L50.
- Showers, Model 4L75 - 7070 concealed bath / shower mixer.

Provide CP right angle stop taps (mini type) at rough in point preceding connection to lever mixer taps.

Taps, water and gas outlets and other fittings shall be bright chromium plated. Tap ware handles shall be anti-vandal type and the colour of the indicator shall be in accordance with the following: -

Standard Tap Handles:

Cold Water Taps - Blue

Hot Water - Red

Warm Water Taps - Yellow

Mattsson Lever Mixer Taps:

Two Cold Water Leads - Blue

Cold & Warm Leads - Blue and Yellow

Cold and Hot Leads - Blue and Red

Provide and install to all wall mounted and hob mounted taps, extension spindles of sufficient length to enable top cover plates to be screwed onto spindles. In determining the length check thickness of wall finishes and benches described in the architectural drawings and specification section.

Provide and install to each tap spindle and bonnet assembly where within dry and masonry walls a "Water Bar" tap penetration flange designed for the purpose of preventing water entering the wall. Provide these flanges to all taps and outlets at baths, showers, sinks and tubs.

Water outlets shall be the aerated type unless otherwise specified to be spray type or without aerator or spray nozzle.

Seal sanitaryware, wall surfaces, bench/counter tops with white anti-fungal silicone sealant.

Plugs and washers for basins shall be 40mm diameter chrome plated brass, complete with approved type plastic plug, grey in colour. Plug and washers for stainless steel sinks shall be stainless steel on plastic type complete with approved type plastic plug, grey in colour. Plastic plug and washers in wash basins are not acceptable. Set each plug and washer in position with clear anti fungi Silicone Sealant.

The number of tap holes in sanitary fixtures must be the same number of outlets required by the Tapware Schedule.

Water closet pans shall be set to the floor with 2:1 cement mortar mix. Pure white sand shall be used in the mortar mix.

Provide "Clark Epure" Model EML W Multilink 50mm plus and waste with high level offset to vertical waste pipe at back of tea and kitchen cupboards this is required so maximum usable space is achieved inside cupboards.

SECTION 7 - SEISMIC BRACING / RESTRAINS

7.1 GENERAL

7.1.1 CROSS REFERENCES

General

Conform to the *General requirements* work section.

Related work sections

Conform to associated work sections as follows:

Hydraulic general requirements.

7.1.2 STANDARDS

AS1170.4 Structural Design Action - Earthquake Actions in Australia

All hydraulic plant, equipment and supports shall be fixed to the building in accordance with AS1170.4 (including Section 8).

For IL4 buildings (projects with post disaster function), a special study is required to ensure the facility remains 'Serviceable for Immediate Use' post-earthquake and cyclone events (1 in 500 years). Building importance level definition remains the responsibility of the building owner/end-user via a risk assessment mechanism in the NCC.

AS5216 - Post-installed Anchors

All anchors used for seismic bracing shall be rated by the manufacturer for seismic loads

7.2 DESIGN

General Provisions

Arrange all components, other than service items exempted in AS 1170.4 Clause 8.1.4, to resist seismic loads determined in accordance with AS 1170.4

- Securely fix all hydraulic plant and equipment to the building structure. Do not rely on gravity and/or friction to resist seismic forces.
- Where anti vibrations devices (such as spring mountings) are used, they shall be horizontal and vertical restrained type, to inhibit the development of resonance in the flexible mounting system, and to prevent overturning. If these cannot be used equipment to be fixed or restrained separately to the spring mountings.
- Do not use hydraulic equipment or components that will be damaged by earthquake conditions. Protect systems against the adverse effects of components such as mercury switches that, although not damaged by earthquake, may malfunction.

7.2.1 Seismic Restraint and Expansion/contraction

- General: Seismic restraint shall be in accordance with AS1170.4 and an associated Seismic Engineering Specialist detail drawing.
- Method of fixing floor mounted equipment shall be in accordance with AS1170.4 and an associated Seismic Engineering Specialist detail drawing.

7.2.2 Description of Work

- Seismic restraints are designed to limit the movement of equipment and to keep equipment captive during a seismic event.

- Non-compliance with seismic restraint requirement shall be corrected by the contractor in an approved manner.
- The work in this section includes, but is not limited to the following:
    - Seismic restraint for hydraulic systems and equipment.
    - Equipment and conduit buried underground is excluded but entry of services through the foundation wall is included.

Typical Hydraulic equipment to be restrained is as follows:

- Piping distribution systems
- Suspended gravity drainage systems
- Hot water plant

Items not specifically mentioned in AS1170.4 section 8.1.4 are considered to require restraint by "All other components similar to those listed" and may include shelving, items installed in ceiling voids, cranes, building maintenance units, water storage tanks, systems involving hazardous materials, pressure vessels and heat exchangers, solid fuel heaters, water treatment equipment, waste disposal equipment, air handling plant and fans, automatic control systems and BMS, cable trays, ladders, busbars, conduits, plinths, fuel storage systems, batteries and UPS.

- Seismic restraint shall be installed in accordance with AS1170.4. Provide calculations signed by structural engineer licensed in the Australia in which the work is to take place certifying that seismic restraints will act in accordance with the relevant standards stipulated in the specification and will maintain equipment in captive position

7.2.3 Seismic Design Criteria

The following is a list that is needed for seismic engineering and may be obtained from the structural engineer associated with the project.

- Building/Structure Importance level (IL#)
- Earthquake design category (EDC)
- Hazard Design Factor (Z)
- Site sub-soil class
- Probability Factor

7.2.4 Provisions

Comply with the following as a minimum:

Arrange all components to resist the design earthquake loads as determined by the use of AS 1170.4-2011.

Restrain all hydraulic components against seismic loads including those parts and components identified in Clause 8.1.4, AS 1170.4-2011.

Plant and equipment: Securely fix all hydraulic plant and equipment to the building structure. Fixings shall have a load-transferring capacity equal to or more than that determined by the use of AS 1170.4-2011.

Fixings: Fix all hydraulic components to withstand earthquake loads determined in accordance with AS 1170.4-2011 Do not rely on gravity and friction to resist seismic forces.

Anti-vibration mounts: Use horizontally restrained type with a load-transferring capacity equal to or in excess of that determined by the use of AS 1170.4-2011. If this is not possible use snubbers or equipment clips to restraint with free springs.

Submission: Provide evidence that the fixings and vibration isolation installed comply with the requirements of AS 1170.4-2011. Include the provision of a design certificate with calculations certified, by an experienced and practicing structural engineer.

Material submittals shall include, but not limited to the following information:

• Catalogue cuts and data sheets on specific restraints on other equipment to be utilised, showing compliance with the specification.

• A list of the items of equipment to be restraint, the proposed seismic restraint types and models, and seismic restraint loading.

7.3 SUBMISSIONS

7.3.1 Shop Drawings:

- Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations as well as the integration of vibration isolation.
- Where walls, floors, slabs, or supplementary steel work are used for seismic restraint locations; details of acceptable attachment methods must be included and approved before the condition is accepted for installation. Restrain manufacturer's submittals must include spacing, static loads and seismic loads at all attachment and support points.
- Provide specific details of seismic restraints, vibration isolation and anchors; include number, size, and locations for each piece of equipment.

7.3.2 Seismic Analysis:

- Seismic restraint calculations must be provided for all connections of equipment to the structure.
- Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilised for connections to equipment and structure.
- Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, acting through the equipment centre of gravity. Overturning moments may exceed forces at ground level.

7.3.3 Contractor's Responsibilities

The following is the minimum contractor's responsibility:

- Engage a Seismic Design Specialist to:
  - Conduct a Special Study as required by AS1170.4
  - provide specific engineering design of all seismic/wind restraints.
  - advise appropriate service clearances.
  - perform installation inspections, and
  - provide certification the design requirements have been met.
- Confirm with relevant trades that all walls, ceiling and partitions are engineered for the loads of engineering services elements and ensure that appropriate service clearance requirements have been met.
- Ensure values for all parameters with the Structural Engineer and allow to adjust calculations and equipment selections as required prior to ordering equipment

- Carry out all remedial works due to failure to meet the above responsibilities at no cost.

7.3.4 Document Submittals

Submit the following documentation prior to commencement of work or ordering of equipment

- Design computations for all design items and check as required within this specification including:
- Equipment support seismic computations.
- Seismic restraints design, locations and auditable load calculations
- Adjusted services pathway illustrating minimum service clearances as outlined in specific engineering design and coordination with relevant trades.

7.4 INSPECTIONS AND VERIFICATION

Prior to installation of ceilings, notice shall be given for inspection by Seismic Design Specialist and main contractor of in-ceiling systems, seismic anchors and seismic restraints.

Seismic Design Specialist to provide a Construction Monitoring Report for submittal for installed restraints and braces.

Failure to give notice will result in cutting and patching of coverings for spot checking. Prior to practical completion, Seismic Design Specialist shall issue certification that installation meets design requirements, signed by qualified structural/seismic engineer.

7.4.1 Services Expansion/contraction

Refer to structural drawings for location and details of building expansion joints. Perform, submit, coordinate and provide calculations for all aspects of pipe and duct expansion and contraction including:

- Building expansion joints (movement 75mm in all directions as described)
- Temperature variations across all conditions including construction, operation, building or part building isolation/shutdown under all possible weather conditions
- Anchor locations, forces and construction details. Coordinate with the Managing Contractor and provide all necessary structural support as required.
- Arrange reticulated services and equipment to avoid excessive movement, forces and stress in pipework and ductwork and to eliminate the risk of pipe, duct and equipment connection fractures.
- Provide appropriate lengths of hanger, pipe/duct guides, saddles, rollers, anchors, changes of direction, expansion loops, spring hangers, expansion bellows, etc. as required.
- Acoustic penetrations shall be arranged to allow necessary longitudinal and lateral movement.

Provide design certificate with calculations, certified by an experienced and practicing Structural/Seismic Engineer.
All pipe and duct systems shall accommodate the following building joints expansion:

- Horizontal movement:
- Vertical movement:

7.4.2 Services Clearances

- Minimum clearances for services shall apply as per below table

- These clearances include services and other structural and non-structural elements, including but limited to pillars, ceiling hangers, wall studs, etc.

- Such service clearances need to be allowed for in the design, with pathways adjusted, and any changes communicated to other trades and project management.

The following minimum clearances must be achieved:

Condition being considered	Minimum Clearances	
	Horizontal	Vertical
Unrestrained component to unrestrained component	250 mm	50 mm
Unrestrained component to restrained component	150 mm	50 mm
Restrained component to restrained component	50 mm	50 mm
Penetration through structure such as wall or floor	50 mm	50 mm
Restrained services passing through the ceiling	25 mm	25 mm
NOTE: ceiling hangers and braces are considered to be restrained components for the purpose of this table, hence 150 mm horizontal clearance is required between ceiling hangers and unrestrained services		

7.4.3 Seismic Testing & Component Importance Factors

The Equipment Schedule indicates the Component Importance Factors (I_p) applicable to equipment and the systems associated.

The Equipment Schedule indicates where equipment/plant shall be capability to maintain its integrity and remain operational in the event of earthquake. Such evidence shall be provided by the Manufacturer/supplier.

7.4.4 Equipment Fixing

All equipment mounting and fixing points to be verified as adequate to withstand seismic events nominated in the project documentation, utilising seismic fixings/restraints where required to provide a complete system.

Anti-vibration and acoustic isolations systems shall be fixed with seismically stable isolator mounts or restraints incorporated.

All bracing shall be independent of the main item support (gravity/vertical support system) unless designed by a Seismic Design Specialist. All post-installed anchors for bracing shall meet the requirements of AS5216.

All fixing of equipment to concrete plinths and piers shall be in accordance with seismic requirements from the contractor's Seismic Design Specialist. Plinths shall be designed to withstand seismic loads being imposed by the supported equipment, with adequate depth and edge distances for anchor capabilities and suitably connected to the structure to transfer the required loads.

IL4 structures fix only to building structural elements or to steel framing fixed to structural elements. Do not fix to masonry infill panels unless specifically designed and certified by a Seismic Design Specialist.

7.4.5 Bracing Location

The Seismic Design Specialist shall provide bracing locations, restraint capacities, suggested brace types and transparency of calculations.

General rules of bracing

Unless exempted, all building services shall be braced:

- when penetrating walls/soffits/floors, unless directed by Seismic Design Specialist.
- both sides of piping, conduit or ductwork at flexible connections
- to avoid collisions between piping, conduit or ductwork and adjacent other non-structural components
- within 600mm of changes in direction, whether it be horizontal or vertical changes (note that offsets of less than 600mm along a run are not considered a change of direction)
- in both directions at the top of all risers where risers exceed 900mm.

7.4.6 Restraint exemption clarification

The exemptions outlined in AS1170.4 Section 8.1.4(b)(x) require specific engineering design knowledge, although the following is noteworthy:

- The exemptions apply to IL2 & IL3 structures only.
- IL4 structures require a Special Study (Specific Engineering Design) before any exemptions apply.
- The exceptions only apply to 'individually supported services'.
- If a straight run of service is exempt at one end and ends non-exempt at the other end, then the whole run should be braced, not just the non-exempt section. The same applies where the hanging distance varies from less than 300mm to more than 300mm in a straight run.
- Where below threshold items are supported on a trapeze or multi service hanger exemption is no longer valid.
- Where a mix of exempt and non-exempt items are within the same support exemption does not apply.
- Exemptions do not apply to the following services:
    - Smoke control systems.
    - Emergency electrical systems (including battery racks).
    - Fire and smoke detection systems.
    - Fire suppression systems (including sprinklers).
    - Life safety system components.
    - Boilers, furnaces, incinerators, water heaters, and other equipment using combustible energy sources or high energy sources, chimneys, flues, smokestacks, vents and pressure vessels.
    - Communication systems (such as cable systems, motor control devices, switchgear, transformers and unit substations).
    - Reciprocating or rotating equipment.
    - Utility and services interfaces.
    - Anchorage of lift machinery and controllers.
    - Lift and hoist components including structural frames providing support for guide rail brackets, guide rails and brackets, car and counterweight members
    - Escalators
    - Machinery (manufacturing and process)
    - Lighting fixtures
    - Electrical panel boards and dimmers
    - Conveyor systems (non-personal)

SECTION 8 - FIRE HYDRANT SERVICES

8.1 GENERAL

The work under this section comprises the supply and installation of the fire hydrant service, including valves, hydrant valves, brackets and bolts, necessary to complete the installation in accordance with AS 2419.1-2005 and in compliance with requirements of Fire & Rescue NSW and other Authorities.

8.2 FIRE HYDRANT PIPEWORK

SERVICE	PIPE DIAMETER in mm	PIPE MATERIAL
Incoming Fire Hydrant Watermain and discharge Fire services pipework from fire brigade boosters to inlet of the fire hydrant pumps. Also all in ground fire hydrant watermains including DN 25, PE, PN 16 pipeline to 150 diameter pressure gauge and fire sprinkler watermains from pump enclosure	As indicated on the drawings	PE Pipe PN16 with red stripe pressure pipe in straight lengths with electrofusion coupling fittings. Provide red coloured detectable marker tape over with works "Fire Main". Fire hydrant and fire sprinklers services tape to have copper wire bound within. Connect polyethylene pipe to uPVC pipe or copper pipe with 316 grade stainless steel table "E" and 316 grade stainless steel bolts and nuts.
Fire Hydrant systems aerially within building, at brigade boosters and fire hydrant standpipes externally.	100	316 grade stainless steel steel fire hydrant pipe. All pipe fittings and joints shall be suitable for boostered pressure up to 1700 kPa and couplings pressure rated to 2100 kPa.

Bolts and nuts used underground and above ground shall be 316 grade stainless steel.

Flanges required underground shall be 316 grade stainless steel.

Metal backing flanges behind polyethylene electrofusion stub flanges required underground shall be 316 grade stainless steel.

8.3 PIPE WORK CONNECTION TO EXISTING WATER MAIN

The Sub-Contractor shall allow to locate, excavate over, install water service connect to the existing watermain, backfill excavated trench and reinstate surfaces to the satisfaction of Local Council requirements and other Authorities. Pay fees and costs to Local Council/Authority.

8.4 SURFACE REINSTATEMENT

Reinstate all surfaces or make good as directed by the Consulting Engineer, including reinstatement of existing turf surfaces that are damaged or removed as part of the installation works. Reinstatement work shall be carried out so as to match the surrounding surfaces and shall be left in a condition at least equal to that in which it was prior to the installation works,

8.5 EARTH COVER OVER PIPELINES AND BACKFILLING OF WATER SERVICE TRENCHES

Prior to any backfilling being placed, the installed water services shall be inspected by the Consulting Engineer who, if satisfied, shall indicate that backfilling may proceed.

Placing and Cover - backfilling shall be carefully packed and consolidated by mechanical means.

All trench backfill in trafficable areas shall be consolidated with approved material to 98% standard compaction.

All pipes not in roadways shall have a minimum cover of 500mm, except where a cover of structurally designed reinforced concrete is provided. All pipes in roadways shall have a minimum cover of 750mm. Provide cement stabilised sand, backfill to all pipe trenches where in roadways. Remove all excavated material to tip and pay tip fees.

8.6 FIRE HYDRANT VALVES

Fire Hydrant valves shall be 65mm diameter standard fire hydrant landing valves with bronze body and with approved, forged aluminium, "Storz" quick couplings, suitable for connection by the local fire brigade.

Position fire hydrant valve centreline 750mm above finished level and allow to direct outlets to meet with the approval of the Authorities.

Each valve outlet shall be fitted with red plastic cap and stainless steel ball chain which shall be attached to the cap and the valve body.

Allow for the handwheel of the valve to be 100mm clear of any wall.

The outlet of the landing valve is to be:

- At right angles to the face of a wall, if any, immediately behind, or
- If horizontal or sloping, not more than 35 degrees below the horizontal.

Body of fire hydrant valves are to be entirely of bronze construction. No other body material will be accepted.

8.7 HYDRANT VALVE CONNECTORS

The Commissioner of Fire & Rescue NSW has determined that the preferred fire hose coupling of Fire & Rescue NSW is Storz Hermaphrodite. Accordingly Fire & Rescue NSW requires Storz Hermaphrodite couplings to be provided.

Clause 7.1 of AS 2419.1-2005 states in part "hose couplings shall be compatible with those used by the fire brigade serving the area". Fire & Rescue NSW requires forged aluminium alloy Storz hermaphrodite delivery couplings manufactured to DIN 14303.

Connectors manufactured to DIN14303 are forged, thus they are more robust and durable than cast connectors. This significantly reduces the possibility of the connector being distorted or damaged.

Storz hermaphrodite connectors shall be fitted to all hydrant valve inlets and outlets including boosters, feed hydrants, attack hydrants and hard suction outlets. All connectors must be fitted with delivery washers except hard suction connectors, which must be fitted with a suction washer. All Storz connectors shall be fitted with a blank cap (refer to Clause 2.8 of AS 2419.1 - 2005).

65mm diameter connectors shall be fitted using standard Fire & Rescue NSW thread of 64mm x 4.88mm pitch (2V2 x 51/5 TPI). A low strength thread sealant is recommended for use between the connector and pipe thread.

It is the opinion of Fire & Rescue NSW that these are connectors and not fittings, thus not part of the fixed system to which the national plumbing code (AS 3500) relates. 65mm Storz connectors should be attached semi-permanently using a low strength sealant so that a damaged connector is able to be removed by a firefighter using a hose spanner and a Fire & Rescue NSW connector used instead.

8.8 NOTICE OF PRESSURE AT FIRE BRIGADE BOOSTER

A fade resistant engraved sign shall be fixed in a prominent position adjacent to the fire hydrant and primary backflow prevention device. The following words shall be indicated on the signs in upper case lettering 25 mm high and in contrasting colour with that of the background:

- Working Pressure (*) kPa
- System Pressure (*) kPa

8.9 FIRE HYDRANT SYSTEM BLOCK PLANS

Provide Block Plans as required by AS2419.1 -2005 of minimum dimensions 840 long and 600 high located in the following positions:

Fire Hydrant System

a) Adjacent to the main incoming fire hydrant backflow prevention device
b) At the main entrance to the building.
c) At the principal vehicle entrance to the site.

8.10 ISOLATING VALVES LOCATED BELOW GROUND IN FIRE HYDRANT SYSTEMS

Isolating valves installed below ground shall be suitably tagged or marked by either post, reflective marker or reflective paint, onto access covers in 25mm high text, and shall:

(a) Conform with Clause 8.5.8 of AS 2419.1-2005 and be located in a fully drained pit: or

(b) Be key-operated sluice valves complying with AS 2638 refer Figures 8.5.9 of AS 2419.1 - 2005 and be clearly identified with permanent ground marking showing the valve number on the block plan.

8.11 UNDERGROUND PIPE WARNING TAPE

Plastic warning tape 100mm wide shall be laid above all underground water service pipes. Tape be colour to comply with AS 1345 printed with the appropriate water service words. Tape shall contain copper wire fixed each end at ground surface.

8.12 LINE MARKING FIXING BLOCKS AND IDENTIFICATION PLATES FOR UNDERGROUND PIPE WORK SERVICES

Provide and install Line Marking Fixing Blocks and Identification Plates for Underground Cold Water pipe work. Different identification plates shall be provided for each water service. Plates shall be 100mm x 100mm x 3mm thick stainless steel screw fixed to concrete with stainless steel expansion fastenings. Engrave details onto plates.

8.13 PIPEWORK PROTECTION FOR IN GROUND COPPER PIPE IN FIRE HYDRANT SERVICES

Install all external, in ground copper pipework in polyethylene blue sleeve protection bag conforming to AS 3680 with joints lapped 600mm and tape sealed.

8.14 PRESSURE GAUGES

Gauges shall be K.D.G. type except where otherwise noted on the drawings. The faces on the gauges shall be 100 mm diameter. Gauges shall be graduated in metres head and kilo Pascal.

Gauges shall register one-third kPa more than the maximum possible pressure obtainable from the system served.

Each gauge shall be complete with bronze ball valve and sufficient copper piping for connection to the pipe work.

8.15 PRESSURE SWITCHES AND ALARM LIGHTS

Provide all electrical wiring within PVC conduits from pumps electrical control panels to pressure switches and alarm lights shown on the drawings.

8.16 ACHIEVEMENT OF FIRE RATING TO FIRE HYDRANT PIPEWORK SUPPORTS PIPE BRACKETS AND CLAMPS

The Australian Standard AS2419.1-2005 in Clause 8.7.4 requires that steel hanger rods, brackets and clamps installed to support and fix in position 316 grade stainless steel fire hydrant pipework when not installed within fire stairs or in a fire sprinklered area, shall have a FRL not less than 60/60/60 when 500°C temperature is in the general area of the pipe support brackets.

To achieve a FRL of 60/60/60 to pipe supports and brackets the hydraulic trade shall engage and pay all costs to an accredited applicator to supply Promat "CAFCO 300" vermiculite gypsum based wet mix spray to all steel pipe supports and brackets so that the recommended vermiculite gypsum thickness satisfies the FRL of 60/60/60.

Provide to the project manager a certificate of application on completion of the works.

Contact details are:

Promat Australia Pty Ltd (Promat Sprays Division Australia) Telephone 9683 2872 Mobile Tel 0428 555 982, Peter Watson.

ALTERNATIVE:

To achieve a FRL of 60/60/60 to pipe supports and brackets the hydraulic trade shall utilise Caddy Erstrut channels 41mm X 41mm X 2.5mm or and equivalent tested support achieving an E90 rating when tested in accordance with DIN4102-12. The strut channels must be installed in strict accordance with the manufacturer's specification and recommendations.

Provide to the project manager a certificate of application on completion of the works.

8.17 TESTING OF FIRE HYDRANT PIPEWORK

Pressure test the entire fire hydrant pipework system to 1700 kPa.

8.18 COMMISSIONING TESTS TO VERIFY PERFORMANCE OF FIRE HYDRANT SYSTEMS WHICH INCORPORATE BRIGADE BOOSTERS

8.18.1 COMMISSIONING OF THE FIRE HYDRANT SYSTEM

The fire hydrant system shall be commissioned in accordance with the requirements of AS2419-2005 Section 10. Every hydrant landing valve in the system shall be opened and tested to prove water availability at the valve.

8.18.2 PRESSURE TESTING THE FIRE HYDRANT SYSTEM

Fire hydrant pipe work systems shall be water pressure tested to 1,700kPa at the highest fire hydrant valve in each system or pressure zone.

8.18.3 TESTING FOR FIRE HYDRANT SYSTEM INCLUDING SYSTEM PRESSURE ZONES INCORPORATING ON-SITE PUMP

- With the on-site pump running, flow and pressure test at the most disadvantaged hydrant(s) for a duty of 10 l/s at each hydrant valve to achieve a minimum of 700kPa pressure.

8.18.4 TEST AND COMPLIANCE CERTIFICATE

A test compliance certificate verifying performance of the fire hydrant system shall be provided to the Consulting Engineer.

Information required in the Test and Compliance Certificate shall be as listed below:

- Date of commissioning test
- Name and address of the property
- Name and contact details of the organisation performing the test
- Identification of the system
- Results of the test
- Signature of the person that carried out the tests

8.19 CERTIFICATION OF FIRE HYDRANT SYSTEM

Allow in Tender and pay fees for approved, Registered Certifier to attend the site to carry out tests on the Fire Hydrant system and to provide certification for installation and pipework system. Such a firm and personnel shall produce documentation to provide evidence as being accredited to undertake the work required.

The certifying company shall provide typewritten results of flow test, static pressure test and flow pressure test at each fire hydrant in the project. Provide test results to Consulting Engineer.

At completion provide filled out and signed originals of all certification forms required by Authorities.

SECTION 9 - TENDER FORM – HYDRAULIC SERVICES

PROJECT NAME: _____

I/WE_____

hereby tender for the supply, installation, testing and commissioning of Hydraulic Services in the abovementioned complex all in accordance with the Drawings and Specification prepared by JHA Consulting Engineers

Itemised Lump Sum Tender Price	**Fixed Price** **$**
Sanitary drainage system including trade waste pretreatment structures	
Downpipes	
Trench base support for sewer and stormwater drainage as specified. Tender to include costs for payment of geotecnical engineer to test base of trenches	
Hot, warm and cold water systems including hot water heaters and pumps	
PC Sum for sewer pump station	
PC Sum for sewer rising main relocation	
Preparation and submission of workshop drawings	
Purchase and install sanitary fixtures and tapware	
"As built" drawings and operating instructions manuals	
Testing, commissioning and certification of all hydraulic services, pumps, controls, valves and vessels including hydrant flow test with appliance and all other required tests	
Preventative maintenance for twelve months as specified	
Fire extinguishers and fire blankets	
P & D inspectors fees and council fees	
Total tender price	
GST	
Total tender price including GST	

Total in words .....Dollars

I/we.....

Unconditionally guarantee of plant, equipment and system performance as detailed in the specification and tender drawings and completion in accordance with the building programme

NAME ON TENDER	
SIGNATURE	
COMPANY POSITION	
WITNESS DATE	

SECTION 10 - TENDER FORM – LABOUR MONETARY RATES

PROJECT NAME: _____

LABOUR MONETARY RATES

Labour monetary rates shall include all current Award Allowances and any Special Site Loading or specified Site Allowances.

PERSONNEL CATEGORY	**RATES per hour $ excl GST**
Foreman Plumber	
Leading Hand Plumber	
Journeyman Plumber	
Labourer	
Designer and Draftsperson	
Apprentice Plumber	
Other	

NAME ON TENDER	
SIGNATURE	
COMPANY POSITION	
WITNESS DATE	

SECTION 11 - TENDER FORM – SCHEDULE OF RATES

I/We _____ hereby provide the following alternative pricing for the alternative pricing for the alternative materials specifications listed below.

Description	Rate	Unit
Sewer/ Sanitary/Stormwater		
65 dia uPVC drainage, supply and install (inground)	$	per m
100 dia uPVC drainage, supply and install (inground)	$	per m
150 dia uPVC drainage, supply and install (inground)	$	per m
Floor Waste, supply and install	$	per item
100 dia chrome plated clear out, including penetration and pipework)	$	per item
Vinyl Floor Waste, supply and install	$	per item
Stainless steel Fox wash bay sump	$	per item
Coalescing oil plate separator	$	per item
1200L holding tank	$	per item
Sewer Pump Station	$	per item
Sewer Rising Main relocation	$	per item
Water Services		
25 dia Copper type “B” water/ gas service, supply and install (suspended)	$	per m
32 dia Copper type “B” water/ gas service, supply and install (suspended)	$	per m
20 dia Tempering Valve, supply and install	$	per item
20 dia TMV Assembly, supply and install	$	per item
20 dia RPZD Assembly, supply and install	$	per item
32 dia RPZD Assembly, supply and install	$	per item
20 dia Isolation Valves (water)	$	per item
25 dia Isolation Valves (water)	$	per item
32 dia Isolation Valves (water)	$	per item
Hot water unit	$	per item
Dual hot water circulating pumpset with control panel	$	per item
Hose tap outlet, including 3m of 20 dia. copper water service	$	per item
Additional items		
Excavation in rock for 800mm wide trench and 2m deep		per m