FORELØBIG INSTALLATIONSHÅNDBOG

for

RC 4000 SYSTEM

RCSL 44-RT 114

FORORD

Denne installationsmanual er fremstillet af A/S REGNECENTRALEN som en hjælp til kunderne i deres arbejde med forberedelse af lokaler og installationer til modtagelse af et RC 4000 system. Kunderne alene er ansvarlige for dette arbejde.

Da mange forskellige forhold gør sig gældende, er det umuligt at give en universal løsning på installationsproblemerne og derfor skal denne manual kun betragtes som en grov vejledning. Iøvrigt forbeholder A/S REGNECENTRALEN sig ret til at ændre RC 4000 systemets specifikationer og krav til omgivelser, og er således ikke ansvarlig for uheldige dispositioner der er gjort i overensstemmelse med denne manual.

INSTALLATION

Efter tegning af kontrakt om levering af et RC 4000 system vil kunden blive kontaktet af en af A/S Regnecentralens installationsingeniører, og der aftales et eller flere møder, hvor han vil være kunden behjælpelig med planlægning af bl.a. følgende emner:

Valg af lokale
Dobbeltgulv
Luftkonditioneringsanlæg
El - tilslutning
Layout af computerrum
Elektriske støjforhold
Adgangsforhold ved levering
Andre betingelser til omgivelser
Service faciliteter

Kunden er ansvarlig for forberedelse af lokaler og installationer til modtagelse af RC 4000 systemet. Det anbefales at arbejdet påbegyndes i god tid før leveringen. Senest to uger før denne skal lokalet være færdigt og rengjort (også under dobbeltgulvet) for besigtigelse og godkendelse af installationsingeniøren.

Leverancen af et RC 4000 system vil normalt foregå pr. lastvogn. Samtidigt med lastvognen vil installationsingeniøren ankomme hos kunden, således at han kan overvåge aflæsningen, der sker ved et af kunden rekvireret og betalt mandskab, sædvanligvis 3 - 4 mand.

Ved installationsingeniørens ankomst bør han forsynes med de nødvendige nøgler, passersedler og lignende, således at han på et hvilket som helst tidspunkt let kan få adgang til computerrummet.

Når enhederne er bragt på plads monterer installationsingeniøren RC 4000 systemet. Under montagen kan det evt. blive nødvendigt med assistance af enkelte lokale håndværkere.

Umiddelbart efter montagen begynder installationsingeniøren indkøring og kontrol af systemet.

Overtagelsen af RC 4000 systemet sker normalt, efter at dets forskellige funktioner er blevet tilfredsstillende demonstreret for kunden.

Den samlede installationstid vil sædvanligvis være på omkring 2 - 3 uger.

VALG AF LOKALE

For at få en rationel udnyttelse af RC 4000 systemet bør der tages hensyn til følgende synspunkter ved valg af lokale.

1. Hele RC 4000 systemet skal samles i et lokale, idet betjening og ikke mindst service hæmmes stærkt, hvis systemet fordeles i flere rum. Dog kan det være fordelagtigt at placere ekstra konsoller i tilstødende lokaler, idet en del trafik i computerrummet herved undgås.

2. Det lokale, der tænkes anvendt til computerrum, skal være så stort, at RC 4000 systemets enkelte enheder samt et klimaanlæg kan placeres således, at de af A/S Regnecentralen angivne krav til operatør- og servicearealer kan overholdes. Det anbefales at tage hensyn til eventuelle fremtidige udvidelser.

3. Loftshøjden i computerrummet skal være så stor, at der kan monteres et dobbeltgulv, uden at eventuelle minimumskrav til loftshøjden overtrædes.

4. Vinduer bør være anbragt således, at direkte solindfald undgås.

5. I umiddelbar nærhed af computerrummet bør der være mulighed for indretning af lokaler til kørselsleder, operatører og eventuelt ligeledes til kunder og teknikere samt lagerplads for papir, magnetbånd og lignende.

6. Computerrummet bør ikke være beliggende i nærheden af maskiner, apparater eller andet, der producerer kraftige elektriske eller magnetiske støjfelter.

7. Det bør undersøges om gulvet i lokalerne kan bære den aktuelle belastning.

KLIMAANLÆG

Da det erfaringsmæssigt har vist sig at problemerne omkring indkøb, dimensionering og installation af klimaanlæg i computerrummet, er af en sådan art, at de i særlig grad har været vanskelige at løse, er dette emne ekstra grundigt behandlet i appendix 1.

DOBBELTGULV

For at beskytte kabelforbindelserne til og imellem de enkelte enheder i RC 4000 systemet er det nødvendigt at der monteres et dobbeltgulv i computerrummet.
Samtlige kraft- og signalkabler føres til og fra enhederne gennem huller i disses bundplader. Heraf følger at der må laves udskæringer i dobbeltgulvet under disse huller. På tegningerne af de enkelte enheder i afsnit (x) er det vist hvor kabelindføringerne er placeret.
I visse tilfælde kan det være hensigtsmæssigt at lade rummet under dobbeltgulvet tjene som distributionsmedium for køleluft fra klimaanlægget. Dette spørgsmål behandles i afsnit (x)

1. Gulvet bør bestå af kvadratiske plader på maximalt 75 x 75cm som samles til en flade. Disse plader er anbragt på korte søjler således at de understøttes i hjørnerne.

2. Gulvpladerne kan være fremstillet af brand- og vandfast krydsfiner, møbelplade eller af metal. Metalplader har dog den ulempe at de er vanskelige at forarbejde. Til gengæld yder de en bedre brandbeskyttelse end træplader.

3. Overfladebelægningen bør være af vinyl eller lignende. Tæpper eller andet støvsamlende og støvproducerende materiale skal undgås.

4. En kantliste omkring hver enkelt gulvplade sikrer at overfladebelægningen ikke så let løsrives i hjørner og langs kanter.

5. Den frie højde mellem det originale gulv og undersiden af dobbeltgulvet skal mindst være 15cm. Hvis mellemrummet skal fremføre køleluft er min. højden 20cm.

6. De understøttende søjler bør være fremstillet sådan at de kan reguleres i højden således at der kan kompenseres for eventuelle ujævnheder i det oprindelige gulv.

7. Belastningskapaciteten skal være min. 700kg/m^2 og punktbelastning min. 70kg/cm^2.

8. Der anvendes to systemer til sikring af dobbeltgulves stabilitet. Det ene system anvender et gitterværk af vanger som forbinder de understøttende søjler umiddelbart under gulvpladerne. Dette system har den ulempe, at hvis man evt.,som følge af en udvidelse af RC 4000 systemet, ønsker at ændre placeringen af de enkelte enheder, er nødt til at demontere alle kabler i den ene ende.
   Det andet system anvender fastlimning eller fastboltning af understøtningssøjlerne til det oprindelige gulv. Ved dette system kan omplacering af kabler foretages uden hindring. Ulempen ved dette system er at overfladen på det oprindelige gulv tager skade ved fastgørelsen af søjlerne.

9. Hvis der er mulighed derfor, evt. ved en nybygning, bør man overveje at sænke gulvet ca. 30cm således at montagen af et dobbeltgulv kan ske i plan med gulvet i de tilstødende lokaler.

10. Hvis dobbeltgulvet ikke kan monteres i plan med gulvene i de tilstødende lokaler, bør der laves en rampe ved de døre, der skal bruges til trafik med transportvogne. Af hensyn til sikkerheden bør rampen have en fra det øvrige gulv afvigende farve.

11. Hvis det oprindelige gulv er af beton eller lignende støvproducerende materiale, skal overfladen males før montagen af dobbeltgulvet.

12. Det færdige dobbeltgulv skal være vandret med en nøjagtighed på 2mm/m.

LAYOUT AF COMPUTERRUM

Da der er en mængde faktorer, som er afgørende for indretningen af et computerrum, kan der ikke gives nogen standardløsning på dette problem. Bagest i denne manual er der anbragt et klippeark, som viser RC 4000 systemets forskellige enheder i størrelse 1 : 25. Ved hjælp af disse modeller kan placeringen afenhederne i det valgte lokale findes. Iøvrigt kan der gives følgende retningslinier for indretningen af computerrummet.

1. Længden af de standard signalkabler, der forbinder enhederne, sætter en grænse, for hvor langt to enheder kan fjernes fra hinanden. I tabel (x) er de maximale afstande mellem enhedernes kabelindføringshuller angivet.

2. Af hensyn til betjening og vedligeholdelse må kravet om et vist frit areal udenom enhederne overholdes.
   Operatørarealet er det areal operatøren bruger under normal drift. Dette areal skal altid være frit og må ikke overlappe andre enheder eller deres operatørarealer.
   Servicearealet er det areal der er nødvendigt for teknikere og deres instrumenter under service. Dette areal kan overlappe operatørarecler og servicearealer for andre enheder.

3. Operatøren bør fra sin plads ved konsollen kunne se de enheder der har mekanisk arbejdende dele f.eks. magnetbåndstationer, printer, diskfile, plotter o.s.v..

4. Det kan ofte være fordelagtigt hvis der i nærheden af operatørens plads er anbragt et aflastningsbord.

5. Selv om ophobningen af materialer som f.eks. papir til printer og konsol, papirstrimler o.s.v. skal begrænses mest muligt, er det dog nødvendigt at afsætte nogen plads for disse ting, samt for reoler til magnetbånd, idet de bånd der skal bruges på anlægget, skal have været i computerrummet 8 - 24 timer før brugen.

6. Det bør hos leverandøren af klimaanlægget undersøges hvor meget plads dette optager, samt hvor stort det nødvendige serviceareal er.

7. Belysningen i computerrummet bør i bordhøjde være 400 lux. Langs væggene skal der med passende mellemrum være anbragt stikkontakter for teknikernes instrumenter.

8. RC 4000 systemets enheder må ikke være placeret så de rammes af direkte sollys. Evt. må der afskærmes med persienner, gardiner eller markiser.

9. Da støv og snavs har særdeles uheldige virkninger specielt på magnetbånd og disks men også på andre dele af anlægget, må der tages hensyn til dette ved planlægningen af rummet. Således må støvet fra printere og andre kraftige støvproducenter ikke af luftstrømmen fra klimaanlægget føres rundt i computerrummet. Trafik til computerrummet bør begrænses mest muligt og en planlægning der medfører gennemgang skal undgås. Ligeledes er rygning naturligvis forbudt.

10. Det kan anbefales at beklæde loft og evt. vægge med et lydabsorberende materiale, da enhederne producerer nogen støj.

TILSTØDENDE LOKALER

Afhængig af anvendelsen af RC 4000 systemet bør der findes lokaler til forskellige formål i umiddelbar nærhed af computerrummet.

1. Lager til papir, nye magnetbånd, printerfarvebånd, perforatorpapir, o.s.v. kan med fordel anbringes med direkte adgang til computerrummet og forsynes med dobbeltgulv, hvorved kørslen med transportvogne lettes. På lageret bør der findes et skab til opbevaring af rengøringsmidler og værktøj, der benyttes af operatørerne under den daglige rutine. Klimaet på lageret skal være: normal stuetemperatur med relativ fugtighed på 40 - 70 %.

2. Reception og kunderum er nødvendigt hvis der udlejes maskintid til fremmede. I dette eller eventuelt disse lokaler bør der findes: skrivebord for receptionist, skrive- og ventepladser for kunder, telefon, og eventuelt en strimmelhullemaskine samt et arrangement med aflåselige skuffer, således at hver kunde kan få en eller flere af disse.
   Hvis der er væg direkte til computerrummet, kan denne med fordel være udført af glas.

3. Opholdsrum for operatører bør indeholde en skriveplads for hver operatør samt et skab til personlige effekter.

4. Kørselslederkontor skal helst være placeret nær kunderummet og være udstyret med et skrivebord og telefon.

5. Hvis mængden af magnetbånd bliver så stor, at der ikke kan findes plads til dem i computerrummet, må der etableres et båndarkiv. De klimatiske forhold i et sådant båndarkiv skal være så nær forholdene i computerrummet som muligt. Mest fordelagtigt vil det være at placere båndarkivet med direkte adgang til computerrummet, og at lade klimaanlægget i dette også betjene arkivet.

6. Det kan være praktisk at indrette en hullestue hvor strimmelhullemaskinerne er samlet, idet disse på grund af støjen kan genere en hel del. Vægge og loft i denne hullestue bør beklædes med lydabsorberende plader.

TEKNISKE DATA for en 13,5 KVA stabiliseringsomformer.

MOTOR: 3o HK kappekølet asynkronmotor, 3 x 38o V, 5o Hz
fabrikat: TT-ASEA type H 13o L
fuldlaststrøm 27 A (ved 13,5 KVA generator ydelse)
startstrøm ca. 22o A ved direkte start
kuglelejernes levetid 15-25.ooo timer

GENERATOR: 13,5 KVA ventileret kapslet, statisk magnetiseret, selvregulerende vekselstrømsgenerator
fabrikat DAE, Odense, type GBE 3.445
1 x 22o V ± 2,5% 5o Hz ±2 Hz cos.fi = o,8 – 1,0
klirfaktor mindre 8%
fuldlaststrøm 6o A

overbelastningsevne 5o % i 5 min., 1o % i 1 time
kuglelejernes levetid 2o-3o.ooo timer

OMFORMERENS mål:
H = 7oo mm br = 7oo mm lgd = 14oo mm
vægt: 64o kg
inerti: GD^2 = 5o kgm^2 (se udløbskurve)
tilladelige temperaturer fra -2o°C til + 4o° C
do relativ fugtighed: 2o - 8o%
virkningsgrad o,75
varmeafgivelse (tab) 4,5 KW, 4ooo kcal/time

OMFORMERTAVLENS mål:
H = 7oo mm br = 35o mm d = 2oo mm
vægt: 2o kg
tavle: LK-NES type 1oo E-felt kat.nr.144 S 1ool
motorværn: LK-NES type MV 3 relæ 28-4o A 22o V spole kat.nr.272 E 3o37
generatorkontaktor: LK-NES type MV 3 22o V spole kat.nr.272 E 4o33
tidsrelæer: LK-NES type TP 1 S 22o V spole kat.nr. 252 J olol
driftsomskifter: Kraus & Naimer (ingfa.C.Thiim) 5-pol 6o A)

RESERVEDELE: 1 sæt kul - ½ sæt kulholdere - 1 sæt kuglelejer til generator 1
1 spændingsregulator, 1 sæt kuglelejer til motor

GARANTI: Der ydes den garanti, som motor-og generatorfabrikanten yder i henhold til deres garantibetingelser.

BRANDBESKYTTELSE

De enheder som et computersystem er opbygget af er meget følsomme overfor varme. Selv tilløb til en brand, eller en lille brand, kan udvikle temperaturer der kan afstedkomme permanent ødelæggelse.
Også datamedierne som f.eks. magnetbånd og disks er meget varmefølsomme. Længere tids varmepåvirkning ved temperaturer på over 65° C kan forårsage forvanskning af den lagrede information. Temperaturer på omkr. 120° C ødelægger al information på såvel magnetbånd som disks.
For brandbeskyttelse skal der her gives nogle retningslinier, der iøvrigt skal suppleres med de lokale brandværnsmyndigheders bestemmelser.

Bygningstekniske krav:

1. Datamaskinen bør installeres i en brandsikker bygning.

2. Datamaskinen bør ikke placeres i nærheden af rum med brandfarlig virksomhed.

3. I bygninger med flere etager skal computerrummets ~~tag~~ loft være vandtæt.

4. Dobbeltgulv skal helst være af ubrændbart materiale. Et brændbart gulv bør forsynes med brandhæmmende beklædning.

5. Døre der fører fra computer- og lagerrum til andre lokaler bør være selvlukkende branddøre.

Slukningsforanstaltninger:

1. Computer- og lagerrum bør forsynes med branddetektorer. Dette bør ligeledes være tilfældet for rummet under dobbeltgulvet.

2. I computerrummet skal der findes håndbrandslukkere med kulsyre.

3. I lagerrum bør der opstilles trykvandslukkere eller installeres vand-

sprinkleranlæg.

4. Det anbefales at der ved udgangen fra computerrummet anbringes en nødafbryder, der kan gøre hele anlægget incl. ventilation spændingsløst.

Andre brandbeskyttende foranstaltninger:

1. Mængden af brandbare materialer i computerrummet skal begrænses mest muligt. Således skal ophobning af papiraffald undgås.

2. Datamedier og lign. bør opbevares i rum der kun benyttes til dette formål.

3. Den bedste beskyttelse for værdifuld information, som f.eks. er lagret på magnetbånd, er at opbevare kopier af båndene i et specielt båndarkiv, der med fordel kan placeres i en anden bygning. Man bør da have 3 identiske bånd, idet 2 bånd altid er sammen ved ajourføring.

4. Personalet skal instrueres om hvad der skal gøres i tilfælde af brand.

ORDENSREGLER

1. Tobaksrygning i computerrummet er strengt forbudt.

2. Computerrummets døre og vinduer må ikke holdes unødigt åbne.

3. Af hensyn til RC 4000 systemets driftsikkerhed er det nødvendigt at rummet holdes frit for støv. Der bør gives følgende instruktion til rengøringspersonalet:

   a. Dagligt:
   Tømning af papirkurve samt afvaskning af gulvet med en opvredet klud. Evt. kan vaskevandet tilsættes et af gulvfabrikanten nærmere angivet vaskemiddel.

   b. Hver tredie dag:
   Aftørring af alle flader på skabe, borde og vinduesnicher med en fugtig klud.

RC 150

Paper Tape Punch (including console CNS 403)
Technical specification

Dimensions

Width 80 cm. Depth 112 cm. Heigth 97 cm.

Weigth

Net. weigth 56 kg.

Power

Standard peripheral is supplied from CPU

Additional "Paper Tape Punch":
Voltage 220V $\pm$ 10%
Frequency 50 cps $\pm$ 4%
Max. line current 1 amp.
Max. heat dissipation 0,2 kw

Environments

Temperature 16 - 30° C
Relative humidity 40 - 70%

Max. distance

Standard peripheral
From cable opening to:
"Central Processor Unit" cable opening 1 : 9 m
Additional "Paper Tape Punch"
From cable opening to:
"Controller Cabinet" cable opening 1 or 2 : 8,5 m

RC 315

Input/Output Typewriter (including console CNS 404)

Technical specification

Dimensions

Width 80 cm. Depth 112 cm. Heigth 103 cm.

Weigth

Net. weigth 68 kg.

Power

Voltage 220V $\pm$ 10%

Frequency 50 cps $\pm$ 4%

Max. line current 0,4 amp.

Max. heat dissipation 0,1 kw

Environments

Temperature 10 - 40° C

Relative humidity 30 - 70%

Max. distance

From cable opening to:

"Controller cabinet" cable opening 1 or 2 : 8,5 m

RC 433

Magnetic Dics Store
Technical specification

Dimensions

Width 61 cm. Depth 92 cm. Heigth 104 cm.

Weigth

Net. weigth 220 kg.

Power

Voltage 3 x 208V and 220V $\pm$ 10%

Frequency 50 cps + 1% - 2% and $\pm$ 10%

Max line current 1 amp/phase and 4 amp.

Max heat dissipation 1,2 kw

Environments

Temperature 16 - 32° C

Relative humidity 10 - 80%

Max distance

From cable opening to:

" Controller cabinet" cable opening 1 or 2: 8,5m

"Mains panel": 10,5m

RC 610

Line Printer
Technical specification

Dimensions

Width 119 cm. Depth 67 cm. Heigth 124 cm.

Weigth

Net weigth 400 kg.

Power

Voltage 220V

Frequency 50 cps

Max. line current 6 amp

Max. heat dissipation 1,3 kw

Environments

Temperature 16 - 30° C

Relative humidity 30 - 70%

Max. distance

From cable opening to:

"Central Processor Unit" cable opening 1 or 2 : 9,5 m

"Operators console" cable opening : 9 m

"Mains panel": 9,5 m

RC 747

Magnetic Tape Station
Technical specification

Dimensions

Width 57 cm. Depth 57 cm. Heigth 180 cm.

Weigth

Net weigth 166 kg.

Power

Voltage 220V $\pm$ 10%
Frequency 50 cps $\pm$ 4%
Max. line current 5 amp.
Max. heat dissipation 1,1 kw.

Environments

Temperature 10 - 40° C
Relative humidity 30 - 70%

Max. distance

From cable opening to:
"Controller cabinet" cable opening 1 or 2 : 8,5 m.
"Mains panel" : 10 m.

RC 749

Magnetic Tape Station
Technical specification

Dimensions

Width 57 cm. Depth 57 cm. Heigth 180 cm.

Weigth

Net weigth 166 kg.

Power

Voltage 220V $\pm$ 10%

Frequency 50 cps $\pm$ 4%

Max. line current 5 amp.

Max. heat dissipation 1,1 kw

Environments

Temperature 10 - 40° C

Relative humidity 30 - 70%

Max. distance

From cable opening to:

"Controller cabinet" cable opening 1 or 2 : 8,5 m.

"Mains panel" : 10 m.

RC 2000

Paper Tape Reader (including console CNS 402)
Technical specification

Dimensions

Width 80 cm. Depth 80 cm. Heigth 108 cm.

Weigth

Net weigth 113 kg.

Power

Standard peripheral is supplied from CPU

Additional "Paper Tape Reader":
Voltage 220V $\pm$ 10%
Frequency 50 cps $\pm$ 4%
Max. line current 1 amp.
Max. heat dissipation 0,2 kw

Environments

Temperature 16 - 30° C
Relative humidity 40 - 70%

Max. distance

Standard peripheral.
From cable opening to:
"Central Processor Unit" cable opening 1 : 9 m.

Additional "Paper Tape Reader".
From cable opening to:
"Controller Cabinet" cable opening 1 or 2 : 8,5 m.

RC 4005

Central Processor Unit
Technical specification

Dimensions

Width 234 cm. Depth 71 cm. Heigth 145 cm.

Weigth

Net weigth 600 kg.

Power

Voltage 220V $\pm$ 10%
Frequency 50 cps $\pm$ 4%
Max. line current 12 amp.
Max. heat dissipation 2,7 kw

Environments

Temperature 0 - 45° C
Relative humidity 30 - 70%
Cooling air flow 1800 m^3/h

Max. distance

From cable opening 1 to:
"Mains Panel" 9,5 m.

RC 4064

Input/Output Controller Cabinet
Technical specification

Dimensions

Width 234 cm. Depth 71 cm. Heigth 145 cm.

Weigth

Net weigth 350 kg exclusive of device controllers and peripherals.

Power

Voltage 220V $\pm$ 10%

Frequency 50 cps $\pm$ 4%

Max line current 12 amp.

Max heat dissipation 2,7 kw.

Environments

Temperature 0 - 45° C

Relative humidity 30 - 70%

Cooling air flow 1800 m^3/h

Max. distance

From cable opening 1 or 2 to:

"Central Processor Unit" cable opening 1 and 2: 9 m.

"Operators console" cable opening: 9 m.

From cable opening 1 and 2 to:

"Mains panel": 9,5 m.

CNS 401

Operators Console
Technical specification

Dimensions

Width 160 cm. Depth 112 cm. Heigth 103 cm.

Weigth

Net weigth 118 kg.

Power

Supplied from CPU.

Environments

Temperature 10 - 40° C

Relative humidity 30 - 70%

Max. distance

From cable opening to:

"Central Processor Unit" cable opening 1 : 9 m.

"Controller Cabinet" cable opening 1 or 2 : 8,5 m.

"Mains panel" : 10 m.

APPENDIX 1

AIRCONDITIONING AND COOLING EQUIPMENT FOR COMPUTER ROOMS

Purpose.

While in operation computers produce a good deal of heat, and in order to obtain suitable working conditions for the machines and the staff who operate them it is necessary to install airconditioning equipment to serve the computer room. The purpose of the airconditioning plant is to cool, filter - dehydrate in summer and moisten in winter - and when necessary to heat the air and to add a small amount of fresh air.

The computer room.

When planning a computer room care should be taken, with regard to the airconditioning equipment, to ensure that the supply of electric power for airconditioning is separate from the supply (at the main switch box) for the computers because the varying loads imposed by the airconditioning equipment can disturb the smooth operation of the computers. There should preferably be a raised floor (which is also used for feeding the cables to the computers) for partial inlet and suction of air for the room and machinery. If necessary, there should also be an efficient form of shielding against the warmth of the sun - and perhaps also against the heat of interior lighting - since the cooling equipment will otherwise require to be made much larger (and therefore more expensive) than strictly necessary, and if a sunshade is not provided part of the room cannot be used for the location of computers because the sun's direct rays will be too warm. Since the air in the computer room must be maintained at a relative humidity of approx. 50%, appropriate steps should be taken with regard to the risk of condensation on windows and walls and perhaps inside the wall panels.

A description is enclosed of various types of airconditioning equipment. These specifications can be circulated to refrigeration suppliers in connection with an invitation to submit prices.

The specifications should be accompanied by drawings of the computer area, showing orientation and giving information about suspended ceilings, raised floors, interior lighting fittings, any other source of heating, and showing available space for the installation of the airconditioning equipment (on the floor of the computer room, outside the room or suspended from the ceiling).

If a converter is installed, it will be necessary to arrange a suction system to remove the calories produced here.

Certain information in the specifications, such as the amount of heat produced by computers and measuring instruments, hot water available, cool water if any, sunshades and date of completion should be supplied by you, whereas the remaining information can be provided by consultant engineers or perhaps it can be left to the firms submitting tenders to find and calculate the missing information.

Price quotations.

We recommend that you invite tenders from different refrigeration companies because many firms have a number of standard units of various types and capacities, and it is almost always possible to find some that are suitable for the conditions on hand. By selecting standard units, one normally obtains a cheap, reliable and good-quality system for which spare parts are usually held in stock. In addition to the airconditioning plant itself, installations will be required - as indicated later - for water, drainage, electricity and perhaps hot water, and permission will usually be required from various public authorities.

WHAT TYPE OF SYSTEM SHOULD BE SELECTED?

Before making use of the specifications one ought to give some consideration to the type of system one wishes installed. Perhaps you could ask the tendering firms for the prices of various kinds of equipment, and then decide which type you want.

Systems which blow air directly into the room (and often suck some of the air out under a raised floor) or systems with injection of air under a raised floor.

The former type is normally the simplest and often the least expensive but is inadvisable for rooms with a smaller floor area than 50-80 m^2, a ceiling lower than 3.5 m and a large heat load of more than approx. 400 kcal/h and M^2 total because it can very easily give rise to draughts, particularly near walls opposite the point of injection.

Usually the temperature of the injected air is only 11-12° C.

The latter type is employed in circumstances where the first-mentioned system - because of the conditions described above - is unsuitable, and where a raised floor is sufficiently high (normally 25-30 cm), and it can be very suitable for large computer units

in connection with a fresh-air and airconditioning plant for direct conditioning of the room.

Equipment for injecting air under the floor only should not however be used in rooms with very large variations in heat and cold load, e.g. with big transmission losses, sunshine and many computers unless the room also has the above-mentioned airconditioning plant or at least some other means of heating (e.g. radiators) because the temperature in the room is regulated with the aid of the temperature of the same air that passes through the machines, and the temperature range of this air must not exceed an injection temperature between 17° and 24° C.

Systems with watercooled condenser or with aircooled condenser.

A standard type with watercooled compressor built into the cabinet located in the computer room or in connection with this room is the simplest and often the cheapest but in many urban areas the water authorities prohibit the use of water for cooling purposes unless a cooling tower is installed.

If a cooling tower is however used for some other purpose at the same time, it may still be an advantage. Where the authorities permit the use of water for this purpose, the cost of cooling water can be a fairly large item on the annual expense bill. Roughly it can be stated that for a system that operates eight hours a day and requires approx. 20,000 kcal/h the water, at a unit price of about kr. 1.- per cubic meter, will mean an annual expenditure of approx. 3-4,000 kr.

Aircooled condensers with compressors - placed in the open air or with access to plenty of fresh air, and with the cooling battery cooled by the direct expansion of freon - have the disadvantage that they normally create a good deal of noise, and if they are located near residential accommodation they should be very well insulated to dampen the noise. The usually long freon pipelines between the compressor and the cooling unit can also give rise to trouble in the form of condensation and perhaps leakage.

There are also some systems with cabinets, which are cooled by water from a central aircooled or watercooled compressor plant, but these systems are normally more expensive, although they ensure a finer adjustment and can prove advantageous, particularly in special instances where the cooled water can also be employed for other purposes.

Systems with one or more units.

Where conditions permit - without involving a big increase in installation costs - it can be regarded as an advantage to have a system split into several units since this provides a greater degree of safety against a total breakdown of the cooling system, makes it possible to divide a large computer room into zones, and usually makes matters easier if it is later desired to alter the system or enlarge it. In normal circumstances one should allow for the possibility of subsequent expansion because experience shows that this is often likely.

Special systems.

In addition to the systems already mentioned there are more specialised types of equipment.

In areas where installation and service facilities are difficult on account of long distances, etc., it can often be an advantage to select a type for injection of air into the room, with a built-in watercooled compressor, fitted with a humidifier (if necessary) and water filter, and with all automatic controls including thermostat, hygrostat, control panel and relays fitted and wired, all well enclosed and tested. In this way onsite installations will be restricted only to the connection of electricity, water and drainage. The risk of incorrect connections, leakages, etc., will be avoided. In very cold climates where the cost of electricity may be high it can be an advantage to employ a type which uses the cold fresh air in winter for cooling purposes - particularly to reduce the heavy electricity load during the heating season. Systems of this type are therefore normally more expensive to purchase but cheaper to run.

Assessment of tenders.

In assessing tenders submitted by refrigeration companies you should pay attention to price, delivery, terms of payment, extra services, space requirements, capacities, and whether any aircooled compressor will require outside cover. Moreover, one should examine the question of reliability, since - as already mentioned - several independent units are to be preferred to one unit. One should also take into account the possible consumption of cooling water,/the area of heating surface necessary in the units (particularly if these are electrically powered because this can mean more expensive electrical installations and a much higher power consumption when

operating outside the period when the computers are running).

In summer, when the outside air is warm and moist, the cooling system will operate and cool the air in order to remove some of the moisture. When the computers cease operating it is necessary to provide another source of heat in order to maintain the desired temperature. This disadvantage can be reduced considerably by an arrangement with a reduction in operation, by-pass of the cooling surface, or a two-part cooling surface in connection with a shut-off of fresh air outside normal working hours, and an arrangement for this purpose should be included in the assessment.

It is also important in making the assessment to see whether the automatic controls and any electrical material such as contactors and relays are included and fitted and wired to or inside the units because internal automatic and electrical connections can often be relatively expensive.

Attention should also be paid to the operating costs of a humidifier, including the replacement of containers, and the working life and cost of replacement of filters.

Access facilities, stairs, doors, etc., should also be given consideration in relation to the sizes of the various units.

Finally, one should give some thought to the service facilities offered by the firms from whom tenders are received.

In assessing the capacity of a quoted system the most decisive factor to be considered is the maximum number of free (sensible) calories produced by the system, although of course the number of latent calories (dehydration) must be sufficiently high - but there are usually plenty of this category of calorie.

When a system operates with a maximum free heat, this is normally stated in terms of a given expansion temperature (temperature of the cooling battery) at which the compressor unit and cooling battery are at their most efficient. Depending on the temperature, the quantity of air and the design of the cooling battery, in certain cases condensation (dehydration = latent calories) can occur on the cooling surfaces. The number of latent calories greater than necessary for dehydrating the fresh air represents a loss and moreover requires a subsequent moistening; these are therefore undesirable and are a cause of uneconomic operation with a high consumption of electric power.

In order to compare prices it could be useful to complete the following list so that a relatively uniform basis is arrived at for assessing the various tenders.

	1	2	3	4
Quoted price	.....	.....	.....	.....
Extra for special filters (if applicable)	.....	.....	.....	.....
Extra for air ducts (if applicable)	.....	.....	.....	.....
Extra for roof for aircooled condenser unit (if applicable)	.....	.....	.....	.....
Internal wiring connections (including already fitted units? Or has this work to be partly or wholly done under another contract?)	.....	.....	.....	.....
Extra for a system of reducing the dehydration process outside normal working hours (if applicable)	.....	.....	.....	.....
Extra for other additional work, instruments, etc. (if applicable)	.....	.....	.....	.....
Total	=======	=======	=======	=======
Max. no. of free calories produced	.....	.....	.....	.....
Deduction (if applicable) of ventilator heat, if the calories are stated as compressor or cooling surface capacity and not as calories produced by the unit	.....	.....	.....	.....
Price in kr. per kcal/h free calories	=======	=======	=======	=======
Max. total of calories produced	.....	.....	.....	.....
Deduction (if applicable) for reasons stated above	.....	.....	.....	.....
Total	=======	=======	=======	=======
No. of latent calories produced	.....	.....	.....	.....
(Total minus free)				
Deduction necessary for dehydration of fresh air; excess latent calories equal loss	.....	.....	.....	.....
Kw consumption of electrical heating surfaces necessary for reheating air after dehydration (no load)	.....	.....	.....	.....

Suggested conditions of tender

Conditions of tender

Final date of tender: Tenders must reach us no later than .....

Conditions of delivery: The equipment, including all associated work, must be completely installed and ready for operation no later than .....

Terms of payment: To be agreed/.....

General conditions: The work shall be executed in accordance with the appropriate laws and regulations and, unless otherwise agreed, shall be in accordance with the normal conditions stipulated by State institutions in the case of purchases in this particular field in .....
.....
.....
It shall be observed that all parts of the work, regardless whether paid in full or in part, shall be considered to be at the expense and risk of the contractor until the date of completion of the contract.
IT SHALL HOWEVER BE THE RESPONSIBILITY OF THE CLIENT TO CONTRACT FIRE INSURANCE THROUGHOUT THE WHOLE PERIOD OF CONTRACT.

The client reserves the right to select any of the tenders received, or to reject them all.

The main tender and alternative tenders (if any) should include drawings showing dimensions and other information necessary for assessing other work and services required for the completed project, including whether an aircooled compressor can be installed in the open air or whether a roofed construction will be needed.

The tender should also contain a description of the function of the system and its controls.

The tender should state the power requirements for ventilators, compressor, electric heaters, humidifier, pump (if required), etc., and the capacities of the cooling and heating surfaces, compressor, condenser, ventilators, humidifier and filters. With regard to the cooling capacity special mention should be made of the maximum

number of free calories and the maximum number of total calories, with a statement of whether this applies to the compressor, the cooling surface or the whole unit, i.e. including a deduction for ventilators, etc. An indication is also required of the calories necessary to heat the air during dehydration when the system is running without a load.

The tender should be accompanied by a firm and binding offer of a complete service of the equipment.

The tender must include: Supply and installation of the complete system, comprising units with compressors, automatic controls (including technical power contactors, where necessary), relays, air ducts, consoles, piping with valves and automatic controls for freon, the initial supply of freon, insulation of pipes and ducts, starting and regulating of the completed system with detailed test report, and complete details of operating and maintenance instructions.

Unless specifically agreed and included in the tender under a special price, the contractor shall be responsible for all internal electronic and power connections and shall supply the necessary wiring diagrams and instructions, and shall moreover assist the client with information concerning connections for water, heating, etc., and shall include the function of these items in the operating instructions.

The contractor shall submit all applications, etc., to the respective authorities.

Not included in the tender: Structural alterations, painting, carpentry, joinery and plumbing work and connections for electricity, water, heating and drains, unless otherwise agreed.

The contractor shall however no later than two weeks after the receipt of orders to that effect supply all information and dimensions necessary to permit the client to arrange this work.

The contract price: If a tender is submitted for several units, the

contract price should be shown divided into units, with a view to calculation of subsequent enlargements.

Type of system: A tender should be submitted in accordance with the ..... system (see later), with aircooled/watercooled condenser. The compressor(s) should be located .....
.....
The contractor shall however be permitted to deviate from the specified work, if this can be done reasonably, responsibly and as stated in the tender with the object of arriving at a less expensive and/or better installation or operation.

Guarantee: The contractor shall design the details of the system and shall bear full responsibility for the sound operation of the system, with a guarantee that inside conditions are maintained at given outside conditions and loads.

The contractor shall guarantee the system in full for one year from the date of completion, and an amount equal to .....% of the contract sum shall be deposited as security for this guarantee, unless other security has been arranged with the client.

The contractor is under the obligation, on receipt of payment, to perform service requirements and to stock necessary spare parts for a period of 10 years from the date of completion.

Conditions for calculating the system.

Max. outdoor conditions (summer):	..... °C	.....% RH
Recommended for Copenhagen area:	30 °C	50% RH
Max. outdoor conditions (winter):	..... °C	.....% RH
Recommended for Copenhagen area:	22 °C	50% RH
For capacity of aircooled condenser:	..... °C	
Recommended for Copenhagen area:	35 °C	
Conditions desired in the room:	22 °C	50% RH

which should be capable of adjustment between 20°C at 55% relative hum-

idity and 24° C at 45% relative humidity.
Under extreme outdoor conditions the indoor conditions can however be permitted to vary for a maximum of approx. 12 hours annually to 19 °C and 40% or 25°C and 60% RH.
Available cooling water (if applicable) inlet temperature: .....°C.
Available heating medium winter: ..... water/steam
summer: .....
Electric current .....
Heating source, if applicable (radiators with or without automatic controls, ventilation of system) .....
Shielding against the sun .....
Calculated transmission loss in winter ..... kcal/h.

Calculated sun warmth and transmission in summer:	.....	kcal/h
No. of persons of 100 kcal/h:	.....	-
Lighting approx. 20 kcal/h and M^2:	.....	-
Measuring instruments:	.....	-
Computers:	.....	-
Requirement (if any) for side-room:	.....	-
Total no. of free calories:	.....	kcal/h
Heat from ventilators and compressor, if applicable (to be completed by contractor):	.....	kcal/h
Cooling necessary for dehydration (to be completed by contractor):	.....	kcal/h
Total:	.....	kcal/h
Total amount of air intaken by computers:	.....	m^3/h
Necessary addition of fresh air 5% of total air circulating in system (not less however than 25 m^3/h per person:	.....	m^3/h
Quantity of air injected into side-room, if applicable:	.....	m^3/h

Reduction of the calculated maximum refrigeration requirement.

The number of calories arrived at in the above calculation assumes however coincidence of the maximum outdoor conditions and sunshine, fully illuminated lighting, full operation of all the computers, and at the same time operation of all measuring instruments. A further factor to be taken into account is the delay of the sun's warmth through walls in relation to through windows, and the building's own warmth must be considered, particularly if it is constructed of heavy materials, and the system operates, for example, for only eight out of every 24 hours.

Bearing in mind the above factors, it is reasonable to make an estimated reduction in the refrigeration requirement calculated above of approx. 10-20%, particularly if in so doing one can obtain a much cheaper installation on the basis of standard units.

The sound level in the computer room during reduced nighttime operation should not exceed 45 dba and NC 40, and when the whole airconditioning and cooling system is operating the level should be about 55 dba and NC 50 maximum when the average coefficient of absorption is fixed at 0.13, which can be converted in the room roughly speaking to a deduction of 10 db above 10^{-12} watts from the total sound effect produced.

The air-conditioning units consist in principle of a cabinet with an intake for return air, coarse filters of wire netting, fine filters, ventilators suspended in vibration absorbers, cooling surface with or without a dehydration function, heating surface for electricity or/and another heating medium, ventilator with motor, drip-tray for condensation, humidifier (often located outside the cabinet), watercooled compressor (if applicable), air-injection grating or connection to air duct, and the necessary automatic controls, etc., for operation of the system. The units should be encased in a plated jacket, suitably insulated on the inside; they should also have, either located on a readily visible surface or built into an accompanying control panel, some form of signal lamps for operation and stop of ventilators, compressor, humidifer and (if applicable) dehydrator, as well as a signal lamp to show when filters should be changed. The cabinets should be installed on underlays which absorb vibration, and connections to air ducts must be of the flexible type.

Automatic controls must be specified and be of reputable manufacture, e.g. Danfoss, Billmann, Honeywell, Sauter, Siemens, etc., and as many of the controls as possible should be of the same brand.

There is a free choice between electro-mechanical, electronic or pneumatic controls. If pneumatic controls are selected the tender must include the necessary filters, air dryers, reduction stations, compressor and auxiliary compressor.

The automatic controls and the system itself must be designed in such a manner that in the event of a power failure or other fault they stop the ventilator, shut the outdoor air inlet (if any), shut off the humidifier and cooling equipment (if any), and

start the supply of hot water to the fresh-air heating surface (if any).

Any fresh-air heating surfaces which are fed by hot water must be fitted with relief thermostats in case of frost so that the accompanying ventilator is stopped; similarly heating surfaces must be controlled by three-way valves and fitted with circulating pumps. If the computer room has any other non-electric source of heating, for example, radiators, these radiators (in the event that the units do not have a sufficiently large non-electric heating surface) must be fitted with automatic controls for use in winter outside normal operating hours - if such automatic controls are not already fitted.

If the system has both electrically operated heating surfaces and some other means of heating, it should be supplied with an automatic device for switching over to the electric heating surface in the event of a failure in the hot-water supply.

The ventilators must have ball bearings or some other form of bearing that does not require regular lubrication or maintenance.

Around the point at which the ventilators operate their curves must be steep so that the quantity of air from clean to dirty filter does not vary by more than approx. 15% maximum, and when the filter is dirty there must be sufficient increase in pressure to permit the filter guard to function properly.

The fine filters for air must be specified and of a recognised make, e.g. Vokes, Luwa, Cambridge, American Airfilter or Delbag.

In the case of separate fresh-air filters or the recirculation filters to which fresh air is fed unfiltered the following or corresponding degrees of separation must be considered as a minimum: in accordance with A.F.I. or N.B.S. Dust Spot Test 95%, or the D.O.P. (oil vapour or methylene blue - sodium flame test) 85%, or 0.5 my as the top limit according to the German method of testing, and according to A.F.I. section 1 or British Standard 2831 testing dust no. 2 approx. 99.9%.

These tests cannot be compared directly but if the requirements according to one or more of the first eight methods of testing are fulfilled, this can be considered satisfactory.

The last method of testing is however rather uncertain in this particular field and some reservations are therefore to be made.

In principle the same degree of separation is required for clean recirculating filters but if this is impossible or

unreasonable (e.g. with regard to the selection of standard units), a degree of 95% can be permitted according to A.F.I. section 1 or B.S. 2, or of 50% according to the Dust Spot method. This must however be specified in the tender.

Coarse filters: Coarse filters of fine-mesh metal or silk net must be fitted in front of the fine filters for the suction of return air in order to trap fibrous paper dust from the computers. This prevents the working life of the fine filters being shortened unreasonably. These nets must be easily cleaned by removing and brushing (outside, away from the system) or vacuum-cleaning.

Activated-carbon filters: If the intake of fresh air involves the risk of entry of harmful quantities of corrosive vapours, the contractor must include the supply and installation of filters specially suited for the absorption of the vapours. The contractor must make inquiries about this before submitting his tender.

Filter guards: All filters must be equipped with filter guards with a system of visual checking, e.g. the inclined-tube type, Dwyer's filtergage or Honeywell's electric guard with signal lamp.

Heating surfaces: If a supply of hot water is available for heating purposes throughout the year and no allowance has been made for the installation of another sufficient heating source (see under automatic controls), one airconditioning unit must be fitted with a heating surface for this heating medium with sufficient capacity to meet the heating requirement. If a supply of hot water is available only in winter, another unit must have an electrically operated heating surface sufficiently large to meet the air-heating requirement after dehydration outside normal working hours.

If no hot water is available, one unit must be fitted with an electric heating surface coupled in stages or continuously controlled, e.g. by tyristor, sufficiently large to meet both requirements mentioned above.

Heating surfaces for hot water, if employed, must be of a recognised make, and can be made of copper or iron. If closely spaced ribs are used as part of the radiator surface, they should be covered with a form of filter or screen in order to avoid any difficulties with cleaning.

Electric heaters, if used, must be of a recognised brand of manufacture and properly enclosed. They must furthermore be fitted with a thermostat to prevent overheating, and wired in such a manner that they cannot be started when the ventilator is not running.

The humidifier can be of the vaporiser type with electric heater (specify in tender), and the electric power installed for the system must not be greater than necessary for producing the desired amount of steam. The humidifier must be capable of easy cleaning, particularly in areas where the water supply contains large quantities of calcium.

The humidifer may also be of the air-cleaning type with nozzles and spray arrangement; if so, it must include a water tank and circulating pump.

If it is necessary for the water to be treated, this should be included in the tender, accompanied by an estimate of the operating costs for such treatment.

The humidifier must not however be of the type in which the water is atomised in quantities corresponding approximately to evaporated water, even though filters are fitted to remove the calcium dust that separates from the water; even the very smallest quantity of such dust can be most harmful to computers.

Instrumentation: To check the condition of the air there must be thermometers for recording the temperature at the intake point, after cooling and after heating, after a nozzle-type humidifier (if applicable) and, as mentioned under filters, there must also be filter guards.

If the system incorporates heating batteries for water, there must be thermometers for checking the inlet, outlet and circulating temperatures.

Manometers/thermometers must be installed on the refrigeration equipment before and after the compressor and cooling surface, and (if watercooling is employed) on the inlet and outlet points.

All electrical materials must be suppressed to a level equivalent to radio suppression in order to reduce electrical noise. All switches must be built into metal housings. All electronic control cables must be screened, and all power cables must be armoured. This does not however apply to wires which are already enclosed in earthed housings. All screens and armour must be connected to their respective metal housings.

Metal housings must be earthed via cable screens or armour to a higher standard than the requirements laid down for power installations.

The design and location of electrical equipment, particularly control panels and switches, should be undertaken with care because

computers can also be sensitive to emissions, etc.

A check should also be made to see that cabinet inspection doors, etc., are earthed.

Description of the system.

In principle the system should be executed in accordance with the following specifications and the description given on pages 8 and 9 (see however the section on permitted deviations, p. 9). In the assessment of tenders attention will be paid to price, delivery, terms of payment, extra services and space requirements. The question of reliability will also be examined since - as already mentioned - several independent units are preferable to one unit. Account will also be taken of the consumption of cooling water (if applicable) and the area of heating surface necessary in the units (particularly if these are electrically powered because this can mean more expensive electrical installations and a much higher power consumption when operating outside computer working hours); similarly consideration should be given to the relationship between latent and free calories.

In summer, when the outside air is warm and moist, the cooling system will operate and cool the air in order to remove some of the moisture. When the computers cease operating it is necessary to provide another source of heat in order to maintain the desired temperature. This disadvantage can be reduced considerably by an arrangement with a reduction in operation, by-pass of the cooling surface, or a two-part cooling surface in connection with a shut-off of fresh air outside normal working hours.

When the assessment is made, importance is also attached to whether the automatic controls and any electrical equipment such as contactors and relays are fitted and connected inside or outside the units because internal automatic and electrical connections can often be relatively expensive.

Attention is also paid to the operating costs of the humidifier, including the replacement of containers, and the working life and cost of replacement of filters. Access facilities, stairs, doors, etc., will be assessed in relation to the sizes of the various units.

Finally, some thought is given to the service facilities offered by the tendering firms.

System 1.

System for injecting air under a raised floor and with an aircooled condenser located outside the building.

The/

The system can consist of one or more cabinets containing all or most of the functions mentioned above. These cabinets extract recirculation air from under the ceiling or, if the room has a suspended ceiling (and if the construction permits it), from the cavity above the suspended ceiling. The ceiling must however have apertures sufficiently large to permit the warmest air to penetrate into the cavity; approx. 1 m^2 aperture per 4,000 m^3/h is suitable.

The air is then injected under the raised floor and is distributed in one of three ways: directly to machines which suck air under the floor, through grids in the floor, or by machines which extract air from the room and through grids in the floor near walls and doors to the room. These latter grids should have some means of adjustment when the system is being regulated after installation, but are not included in this tender since they belong under the flooring contract.

Doors opening into a colder room or into the open air must have a grid located in the floor the full width of the door, and air must also be injected under high windows in particular.

As the injected air is fed directly to computers, there should be - in addition to the room thermostat which controls the whole system - a minimum thermostat in the injection inlet (normally 19° but minimum permissable is 17°), and if the cabinet is fitted with a heater it should also have a maximum cut-out thermostat (24°). It must be ensured that a sufficient number of calories can be produced at the given quantity and temperature of air, even when the computers are not operating.

One or more room hygrostats control the on-off function of the dehydrator and humidifier. The compressor, aircooled condenser and receiver are placed outside the building or located where they have access to a sufficient supply of fresh air, as close to the unit as possible. If the compressor is located near residential accommodation, the tender should include a suitable form of sound absorption. The contractor should make the appropriate investigations.

In selecting a compressor consideration must be given to the fact that it will be located out-of-doors and subject to frost. It must be guaranteed easy to start, and brief periods of running should preferably be avoided. The compressor should use viscostatic oil.

The system can also include a unit for injecting fresh air, comprising an air-intake duct, ventilators, filter with filter

guard, and injection grid - for blowing air directly into the room. The ducts and unit up to the point of injection must be insulated on the inside with 50 mm mineral wool, glass wool, etc., to prevent the formation of condensation. If the composition of the fresh air constitutes a risk of the occurrence of aggressive vapours, the fresh-air unit must be fitted with the activated-carbon filters mentioned earlier. If the standard equipment allows for it and if there is no other source of heat, it is an advantage if the fresh-air unit can incorporate the heating surface mentioned earlier for meeting transmission loss, etc.

If the system is offered with two or more units, one of the units should include heating (if applicable), cooling, dehydration and moistening equipment, while the other(s) incorporate only cooling and suction of fresh air. With this combination the first unit can operate on its own, without the addition of fresh air, outside normal working hours, and the other unit(s) can be made to stop and start together with the computers or other load.

A mixing system in which the first unit injects air directly into the room while the other(s) operate(s) under the floor - if possible - is to be preferred because the air fed to the computers would thus be maintained at a constant temperature.

Each unit, compressor unit, and automatic control should as far as possible constitute an independent unit.

If more than one unit injects air under the raised floor, care should be taken - for example, under partial load - that an undesirable, irregular load is not placed on the units with, for instance, a cooler working at full capacity while a heater pumps warm air under the floor. If this is theoretically possible, the tender must contain details of an effective mixing arrangement for the air after passing through the units, and this arrangement must be tested during the final period of adjustment.

If the system offered has sufficiently effective recirculating filters, the fresh-air unit can be replaced by a simple duct, insulated on the inside, with a damper for feeding the air to the unit's intake side.

In cases where there is a danger of condensation occurring in adjacent rooms, e.g. on single-glazed windows, some means must be provided for evacuating excess fresh air, perhaps with the aid of a pressure damper.

System 2.

System for injecting air directly into the room and with an aircooled condenser located outside the building.

In the main this system is built up on the same principle as system 1. The cabinet is located on the floor (or suspended on a wall or under the ceiling - in which case the suspended model must be included on the tender). The air is injected horizontally from the top of the cabinet or from the distribution duct with an injection grid, and the contractor must guarantee that troublesome draughts will not cause inconvenience to personnel who have to sit still for long periods.

The contractor must investigate and ascertain that there are no lamp fixtures opposite the air-discharge points, or other fittings that could interfere with the projection of the air stream. The air is withdrawn through the bottom of the cabinet.

If the room is fitted with a raised floor, approx. one-third part of the air should be sucked out of the room via grids in the floor under windows and near doors.

Compressor and fresh-air intake as for system 1.

System 3.

As System 1 but with watercooled compressor and condenser.

This system requires one or more units with compressor and condenser built into the unit, the compressor itself being water-cooled.

The tender must state the necessary quantity, pressure and temperature of the cooling water, and the cooling capacity must be stated for the complete unit, not only for the cooling surface.

Information is also required for the water filters, pump, etc., required.

System 4.

As System 2 but with watercooled compressor and condenser.

See under System 3.

System 5.

As system 4 (or 3) but built as a totally complete unit.

For installation in places where assembly and fitting are difficult on account of distance, etc.

The unit or units must incorporate all components necessary for the finished system, encased in one unit, and built into a strong framework that guarantees safe shipment.

The unit or units must incorporate all the components mentioned earlier: coarse filters, cooling surface, dehydration arrangement, humidifier, water-served heating surface (if applicable) and electrically heated surface, ventilators, injection system, compressor, condenser, automatic controls including built-in and wired thermostats, hygrostat, starters, relays, fuses and a complete set of instruments, and in the case of the cooling water two sets of water filters with changeover cocks, difference manometers and pump (if required). All these components must be installed and connected so that work on the site is restricted to connection of electric power, water, hot water, drainage and fresh air.

The unit must be fully tested and complete in every detail before shipment.

System 6.

System with injection directly into the room or under a raised floor, with the outdoor air in winter being used as a coolant.

This system is designed on the same principles and contains the same components as Systems 1 or 2 (perhaps also as Systems 3 or 4), but in addition has an extraction fan and automatically controlled recirculation damper device; similarly the heating surface for hot water (if applicable) must be equipped with a circulating pump and anti-frost thermostat which starts the hot-water supply, stops the ventilator and re-sets the dampers for recirculation.

As stated, the above specifications and descriptions are intended only as a guide, and the contractor is free within the limits of the specification and provided he gives details in his tender to select a design, etc., of another type - and he bears the full responsibility for the correct operation and reliability of the system.