HOLY ROCK
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الصخرة المشرفة
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مشروع انشاء مزرعة البحث والتطوير –شركة البوتاس العربية

R & D Potash Farm

Specifications & Vendor List

البوتاس العربية
Arab Potash

P.O. Box: 11732
info@hreo-c.com
00962 42 00204
Jordan, Amman, Al-Hurriyah street, Noman Al-Hamshari complex, Bldg#333, 1st floor

Proposed Manufacturers / Suppleirs

Goods Or Material	Name Of Manufacture
All Type Of Concrete (Blinding , Reinforced Concrete)	Zuhairi Brothers Co. For Ready Mix Concrete industries
	Kingdom Concrete
	Manaseer For Ready mix
	Lafarge Jordan
	or approved Equal
GRC (Glass Reinforced Concrete)	Local manufactory
	or approved Equal
Masonry (Hollow Block Concrete)	ASSAS
	Al- Bunian For Cement & Concrete Products
	or approved Equal
Metal Works (Steel Steps , Handrail , Ladder , Metal Deck)	Maani Metal Form Construction
	Sina Metal Fabrication
	Petra
	Third Generation metal Industrial Co.
	Al-Jadaa for metal construction
	Al - Ittehad For Stainless Steel Industries Co.
	or approved Equal
Wood Works (Doors , Cladding , Counters)	Jordan River For Wood Industries (JRC)
	Techtonic
	Integrated Wood Industries (IWI)
	Mashrek Wood Industries
	JWICO
	or approved Equal
Insulation	LAMA
	AIWIN
	Atlas
	JOFOAM
	Fosroc
	DCP
	or approved Equal
Steel Doors (firerated)	Maani Metal Form Construction
	Jadaa
	Sina Metal Fabrication
	or approved Equal

Aluminum Windows , Curtain Walls & Handrail	Petra
	Al - Faqeer
	Muth'har Annab &Co.
	Technical Aluminum & Glass
	Masri Brothers Co.
	Kurdiah & Hakim Aluminum Co.
	Kalbouneh brothers
	or approved Equal
Porcelain Tiles	Europe Origin
Granite	Europe Origin
Suspended Ceiling	KNAUF
	ARMSTRONG
	USG
	or approved Equal
Glass	Saint-Gobain
	Gurdian
	Intraco
	AGC
	Schott
	Emirates Float
	Pilkington
Bathroom partitions	Trespa
	Areel
	Bobrick
Paints & coating	National
	Dulux
	JOTUN
	or approved Equal
Ironmongery	Tesa
	Hafele
	Euro Art
	Consort
	or approved Equal

المواصفات الفنية الخاصة للاعمال الانشائية والمعدنية :

اولا : اعمال الحفريات والردميات

1- قبل المباشرة بأعمال الحفريات على المقاول تزويد المهندس المشرف بمخطط شبكية يبين مناسيب الأرض الطبيعية قبل الحفر وضمن فترات لا تتعدى عن (5) مترلكل فترة وعليه ان يأخذ موافقة المهندس على هذا المخطط.
2- لا تنص هذه المواصفات على وجود مسافة عمل working space حول جوانب الحفريات ولا تكال ولا تدفع ايضا علاوة أو سعر إضافي مقابل عنها.

المواصفات الفنية للطمم والمواد المختارة المستخدمة في المشاريع الابنية والمساحات.

1. المواصفات للطمم من المواد المختارة:

- ✓ التصنيف المجموعي يكون A2−5,A2−4,A1−b,A1−a بمعامل لدونة لا يزيد عن (10)
- ✓ أن لايزيد الحجم الاكبر عن 3

لتحديد الخصائص عادة تجري فحوصات التدرج الحجمي وحدود ايتربورغ (Atterbirg).

2. أما الحدود الدنيا والعليا للمواصفات المتبقية في تحديد التصنيف بناء على نتائج الفحوصات المخبرية فيمكن الاستعانة بجدول تصنيف التربة ومجموعات التربة والحصى حسب المواصفات لجمعية مهندسي الطرق الامريكية (AASHTO).

ثانيا: الاعمال الخرسانية والطوبار وحديد التسليح

1- ضبط الجودة

على المقاول أن يراعي الأمور التالية لغرض ضبط جودة المواد والخلطات الخرسانية والأسفلتية: -

أ- إجراء الفحوصات المخبرية اللازمة وفقا لما ورد في المواصفات.

أ- تصميم خلطة خرسانية أو تصميم خلطة إسفلتية من مختبر معتمد شاملا ما يلي:
1- ان يؤخذ بعين الاعتبار طبيعة العمل أو طبيعة أماكن الصب وظروفه
2- ان يؤخذ بعين الاعتبار عند حساب نسب التصميم أية إضافات على الخلطات في الموقع كالمادة المميعة مثلا وغيرها
3- أن يكون التصميم حاويا لفحوصات الخلطة التجريبية وخواص الخرسانة الطازجة.

ب- على المقاول فحص الخلطات الخرسانية بشكل دوري على النحو التالي:
1- لكل 50 متر مكعب تؤخذ على الاقل ستة مكعبات متماثلة بحيث تفحص ثلاثة بعد أسبوع والثلاثة الباقية بعد 28 يوما.
2- لكل يوم صب إذا كان الصب على مراحل متقطعة ، تؤخذ ستة مكعبات متماثلة ،تفحص ثلاثة بعد أسبوع و الثلاثة الباقية بعد 28 يومًا.
3- يشترط ألا يقل الحد الأدنى لمحتوى الأسمنت / متر مكعب من الخرسانة عن الكمية المطلوبة في المواصفات ووثائق العقد وجداول الكميات ، حتى لو حققت الخرسانة القوة المطلوبة بكمية أقل من الأسمنت.

د- لا يسمح الصب إذا زادت درجة حرارة الخرسانة عند وقت الصب عن 38 درجة مئوية ، كما لا يسمح الصب في الأجواء الباردة التي يقل فيها متوسط درجة الحرارة اليومي عن (4) درجات مئوية ، وعلى المقاول اتخاذ كافة التدابير اللازمة للتقيد بذلك ، وخلافا لذلك فإن المهندس الحق باتخاذ التدابير اللازمة للمحافظة على هذه المواصفة ويتحمل المقاول أي كلفة مترتبة على هذه التدابير دون أن يكون له حق الاعتراض على ذلك.

2- شروط القبـول للخرسانة

أ- أن لا يقل معدل قوة التحمل من درجــة الخرسانة المطلوبة في التصميم المعتمد.

ب- أن لا تزيد نسبة التفاوت 10% من المتوسط لقوة تحمل المكعبات.

ج-أن لا يقل قوة تحمل أي مكعب من 90% عن درجة الخرسانة المطلوبة.

د- في حالة عدم تحقيق شروط القبول للخرسانة على المقاول أن يقوم بأخذ عينات لبية (كور) ويجب أن لا يقل معدل قوة التحمل للعينات اللبية عن 85% من درجة الخرسانة المطلوبة.

هـ- يجب أن لا يقل المحتوى الإسمنتي الخرسانة عن ما يلي :

خرسانة درجة (10) محتوى الاسمنت الادنى (200) كغم /م^3

خرسانة درجة (15) محتوى الاسمنت الادنى (220) كغم /م^3

خرسانه درجة (20) محتوى الاسمنت الادنى (250) كغم /م^3.

خرسانه درجة (25) محتوى الاسمنت الادنى (350) كغم /م^3.

خرسانه درجة (30) محتوى الاسمنت الادنى (350) كغم /م^3.

خرسانه درجة (45) محتوى الاسمنت الادنى (370) كغم /م^3.

و- المضافات والملدنات والمميعات تكون مطابقة للمواصفة البريطانيـة رقم (BS 4887) أو المواصفة الأمريكية رقم (ASTM-C 494).

ز- المواد المانعة للنش تكون مطابقة للمواصفة البريطانية رقم (BS 5075 Part1) أو ما يعادلها.

3- الطوبار

تطبق المواصــفات الفنية العامة للمباني البند (304) على أن يكون الطوبار جديداً وغير مســتعمل في مشــاريع أخرى وأن تخلو ألواح الخشـــب أو الأنواع الأخرى من الطوبار التي يعتمدها المقاول من التقوس والفتلان والعيوب الأخرى وان يتم التأكد من اســتقامة الطوبار عند اغلاقه وعدم تجاوز الحدود المذكورة في البند (7/304) للتفاوتات في الشــاقولية والمناســيب والميلانات والأفقية وأن يتم التأكد من عدم نفاذية الطوبار للخرسانة أثناء الصب.

يجب على المقاول التأكد من تحقيق الغطاء الخرسـاني (concrete cover) المناسـب لحديد التسـليح وكما هو محدد في جداول الكميات والمخططات.

ضــرورة الالتزام بمدد نزع الطوبار المحددة في المواصــفات الفنية العامة أو ان ذكرت في مواقع أخرى من وثائق العطاء والالتزام بمدد ايناع الخرسانة.

ضـــرورة التأكد من تجهيز مواقع البكايات أو أي متطلبات أخرى في حال وجودها قبل اغلاق الطوبار وذلك كما هو محدد في المخططات أو ما تتطلبه المواصفات الفنية والضرورة اللازمة إن لم تذكر في وثائق العطاء.

يشمل السعر العمل في جميع المقاطع والأشكال وعلى جميع الارتفاعات.

4-المخططات التنفيذية لحديد التسليح

على المقاول تقديم الجداول الخاصة بتنفيذ مخططات حديد التسليح (Bar–Schedule Binding) مبينا فيها اطوال واوزان حديد التسليح للمهندس المشرف بغرض اعتمادها قبل التنفيذ (جداول أقيسة).

على المقاول تشـــوين حديد التســـليح في مكان جاف وبعيد عن مصـــادر المياه والرطوبة وفي مواقع تضـــمن ســـلامة العاملين والمحافظة على نظافة القضـبان ويجب على المقاول تنظيف القضـبان والمقاطع التي سـيتم صـبها قبل الصـب واغلاق الطوبار ويتطلب ذلك موافقة المهندس المشرف على الصب بعد تأكده من تحقق الشروط اللازمة.

على المقاول عدم اســتخدام الأدوات أو الأجهزة التي تولد حرارة أثناء قص القضــبان وعليه اســتخدام العدد اليدوية وذلك حتى لا تتاثر قوة الحديد.

على المقاول التأكد من ترك التشاريك بالاطوال المناسبة في كل مرحلة وذلك لتجنب استخدام التشريك من خلال التثقيب واستخدام المواد اللازمة مثل الايبوكسـي أو اسـتخدام طريقة لحام القضـبان، وفي حال تطلب الامر نتيجة خطأ المقاول أو نسـيانه ذلك فإن كلف التشاريك والمواد (الإيبوكسي) أو اللحام ستكون محملة على أسعار العطاء ولا يستحق المقاول أي أتعاب عن ذلك.

رابعا: الاعمال المعمارية

1- مواصفات الحجر الطبيعى للبناء

- يبين الجدول رقم (1) متطلبات المواصفات القياسية الاردنية رقم (م.ف.أ/ 85 / 1992) الخاصة بالحجر الطبيعي للبناء (الحجر الجيري)

الخاصية	صنف أ	صنف ب	صنف ج	طريقة الفحص
الوزن النوعي (الحد الادنى)	2.56	2.45	2.16	ASTM-C97
امتصاص الماء (%) (الحد الاقصى)	3.00	4.20	7.50	ASTM-C97
معاير التمزيق (ن/مم ^{2}) (الحد الادنى)	6.90	5.20	3.40	ASTM-C99
مقاومة التأكل السطحي معاير الصلابة (الحد الادنى)	10.00	10.00	10.00	ASTM-C241
مقاومة الكسر بالضغط (ن/مم^2) (الحد الادنى)	55.00	28.00	12.00	ASTM-C170

- فحوصات المظهر الخارجي يجب أن تكون عينات الحجر خالية من العيوب كالفجوات والجيوب الطينية (الكمخات) والتسوس والعروق والرفش والصوان وتباين اللون.

2- المواصفات الخاصة بالزوايا والشرائح الشبكية المعدنية لاعمال القصارة.

- ✓ ASTM 525/71 G60
- ✓ ASTM C847/77
- ✓ ASTM 366-68
- ✓ ASTM A566-68
- ✓ ASTM A 529 G90

- يكون عرض الشرائح الشبكية الادنى 150 مم ويزداد حسب وضعه الخاص بانظمة الخدمات المخفية وبموافقة المهندس المشرف.
- يكون عرض زوايا الشبكية 75 مم.
- يكون سماكة الصاج 0.5 مم على الاقل.
- يراعى أن تكون المواد اعلاه من الصناعة المحليه.

3-مواصفات الأبواب والنوافذ من الالمنيوم

1- عام

1-1 المجال

أ) يغطي هذا القسم كل ما يتعلق بمستوى المصنعية والمواد وأداء كل العمليات ذات الصلة بتنفيذ أعمال الأبواب والنوافذ من الألمنيوم بكافة أنواعها وأشكالها مع الخردوات وكافة الأعمال التابعة لها حسب ماهي محددة فى المخططات وجداول الكميات وهذه المواصفات.

2-2 التقديمات والاعتمادات

أ) على المقاول أن يقدم للمهندس للإعتماد والقبول مخططات تنفيذية لكافة الأعمال المشمولة بهذا القسم مبينا خلالها:

1) الواجهات والتفاصيل والمقاطع للدرف والإطارات بكافة أنواعها
2) جدول بالأبواب والشبابيك والإطارات مع مواقع تركيبها
3) جداول الخردوات
4) المعلومات التفصيلية والسماكات والحواف والوصلات والإكسسوارات المركبة

ب) تعليمات التركيب من الشركة المصنعة

ج) تقديم عينات من الأبواب والنوافذ كما يلي:

1) عينة إطار باب ألمنيوم على شكل قياس 250 × 250 ملم مبينا خلالها المقطع والمواد
2) عينة درفة شباك على شكل زاوية قياس 250 × 250 ملم مبينا خلالها المقطع والمواد
3) عينة أو كتالوجات فنية للخردوات المنوي تركيبها وتكون من الأنوال المقبولة بالنسبة للنوعية ونوع إنهاء السطح ومطابقة للمواصفات
4) عينة لكل قطع الإكسسوارات والمثبتات المنوي إستخدامها

3-1 التوريد والتخزين

أ) تورد المواد فى عبواتها الأصلية من المصنع وتكون غير تالفة وعليها بطاقة للبيان مسجل عليه كافة المعلومات الضرورية اللازمة

ب) تخزن المواد فى مخزن مغلق غير مبلل وغير معرض للرطوبة والعوامل الجوية

ج) تخزن وتنقل المواد حسب تعليمات الشركات الصانعة وشروط التخزين التي توصى بها

د) تكون جميع الأبواب والشبابيك المجمعة الموردة مفحوصة ومغلفة بطبقات الحماية المطلوبة

2- المنتجات

2-1 مقاطع الالمنيوم

أ) يكون الألمنيوم المستخدم من النوع الذي يحقق المتطلبات العامة للمواصفات القياسية ASTM B209, B221, B308أو BS 4873 ومصنع من الألمنيوم المضغوط. Extruded Aluminum Alloy

ب) يكون طلاء الألمنيوم بطريقة البودرة البوليستر Polyester Powder Coated Surface Finish وسماكة طبقة الطلاء لا تقل عن 70 ميكرون مطابقة للمواصفة القياسية البريطانية BS 6496 وبالألوان التي يحددها المهندس أو المالك. أو بطريقة طلاء الايونات (Anodized) وسماكة لا تقل عن 18 مايكرون وحسب اللون المعتمد من المهندس.

ج) تكون سماكة مقاطع الألمنيوم لا تقل عن 1.6 ملم لكافة الأنواع ومن النوع المفرغ مقطع عريض مكون من طبقتين Double Deck بالنسبة لأرضية الإطار الخارجي وإطار الدرف ومزودة بفتحات ومجاري لتصريف مياه الأمطار.

د) تكون مقاطع الألمنيوم للأبواب والنوافذ مصممة من النوع الذي يستقبل الزجاج المزدوج أو المفرد حسب ما هو مبين على المخططات.

هـ) تكون أشكال وتفاصيل مقاطع الألمنيوم المستعملة بحيث تسمح بإغلاق الأبواب والنوافذ بإحكام وكتامية وذلك بشكل فرزات وأخاديد ومجاري مزدوجة لكل مقطع لتركيب الأشرطة المانعة للمؤثرات الجوية وخلافها ،

وفى الأبواب والنوافذ المنزلقة يجب أن يدخل المصـــراع داخل مقطع الحلق بإحكام وكتامية ، وأن تتراكب المصاريع عند إغلاقها بفرزات خاصة مزودة بفراشي مزدوجة تضمن الكتامية أيضا.

و) تكون المقاطع المستخدمة من المقاطع الخاصة للشركات المحددة في جداول الكميات.

2- 2 المثبتات والأكسسوارات

أ) لوازم التثبيت والقطع المعدنية المستخدمة : مصنوعة من الألمنيوم أو الفولاذ عديم الصدأ والبراغي مزودة بطبقة بلاستيكية ملونة حسب لون الألمنيوم.

ب) عجلات الدرف ودرفة المنخل : من مادة التيفلون الذي لا يصدأ ضمن إطار من الفولاذ الذي لايصدأ ومزودة بركائز كروية (Ball Bearing) من النوع دائم التشحيم. (Permanently Lubricated)

ج) شبك المنخل المستخدم : من النوع المعدني عديم الصدأ قطر 0.19 ملم عيار 16.

د) الأشرطة المثبتة للزجاج : تكون من المطاط بشكل حرف. U

هـ) أشرطة الفراشي : تكون من النوع الذي توصي به الشركة الصانعة.

و) المعجونة : من النوع الأكريليكي متعددة الإستخدام داخلي وخارجي والإستطالة من 10 - 15 % على الأقل مع إستخدام معجونة ذات أساس سيلكون بين الألمنيوم وأسطح الرخام والسيراميك.

ز) يزود الشباك بقطع بلاستيكية لتسكير أماكن خروج الماء وقطع مطاطية لمنع الإرتطام.

ي) شريط تثبيت شبك المنخل : يكون من مادة ال .P.V.C او النيوبرين. (Neoprene)

ح) درفة المنخل : تزود درفة المنخل بعجلات من الأعلى مع نابض زنبركي للتثبيت فى مجراها أويتم تثبيت الدرفة حسب نظام الشركة الصانعة.

2 -3 الخردوات:

أ) المغاليق (Locks) للشبابيك السحابة : (Sliding) من النوع الأتوماتيكي الأمين ذاتي الإغلاف(Automatic Security Lock) ومطابق للمواصفة البريطانية BS 3621 أو الأمريكية ANSI-A 156.2 وتكون من نفس لون الألمنيوم المستخدم.

ب) المفصلات للأبواب والنوافذ المفصلية : من الألمنيوم ويركب ثلاث مفصلات لكل درفة باب لايزيد إرتفاعه عن 225 سم على أن لا تزيد المسافة بين مفصلة وأخرى عن 75 سم (أو حسب توجيهات المهندس المشرف)

ج) الأيادي والمقابض : يركب لكل درفة باب مفصلي زوج من الأيادي مع شمسه (Rose) لفتحة الزرافيل وأخرى لفتحة الأيادي وحسب الشكل الذي يتم اختياره.

د) الزرافيل : يركب لكل باب مفصلي زرفيل سلندر ولكل باب ذو درفتين مزاليج سفلية وعلوية جانبية.

هـ) الإنهاء : تكون الخردوات من الألمنيوم الفولاذ المطلي (Anodized) ويكون إنهاء سطح الخردوات الظاهر بنفس لون الألمنيوم المستخدم (أو حسب توجيهات المهندس المشرف).

2-4 الزجاج المستاطح العائمFloat Glass

أ) يكون الزجاج ذو مسطحات مستوية تماما ومتوازية بدون تشوهات وإنعكاسات منكسرة ، ويستخدم من النوع الشـــفاف للنوافذ الداخلية والطبقة الداخلية من الزجاج المزدوج ومن النوع الملون بالألوان Body Tented للإستخدام الخارجي والطبقة الخارجية من الزجاج المزدوج.

ب) يستخدم للطبقة الخارجية من زجاج شبابيك الحمامات المسطح من النوع المغشى. Obscured

2-5 الزجاج المقوى الأمين سيكوريدTempered Glass

أ) يكون مطابقا للمواصفة القياسية البريطانية BS 6206-Class A ويكون من زجاج معالج حرارياً حسب تحديد جدول الكميات.

ب) عندما ينكسر الزجاج يتحول إلى قطع صغيرة ومقاومته للكسر اكبر 5 مرات من الزجاج العادي بنفس السماكة.

ج) يستخدم هذا الزجاج للأبواب الزجاجية بالكامل و حسب ما هو محدد فى جداول الكميات وتكون السماكة حسب ما هو محدد فى جداول الكميات.

2-6 الاختبارات

أ) يجب أن تجتاز أعمال النوافذ والأبواب المركبة اختبارات نفاذية الهواء والكتامية للماء ، ومقاومة الريح فى المختبر ، ويحدد صـــنف النوافذ والواجهات الزجاجية القابلة للفتح والإغلاف من حيث مقاومتها لنفاذ الهواء بالصنف عالي الأداء لدى فحصها حسب المواصفات القياسيةBS 5369 .

1) اختبارات نفاذية الهواء

- النوافذ والواجهات القابلة للفتح والإغلاف

يتم إختبار النوافذ والواجهات الزجاحية القابلة للفتح والإغلاق لتحديد مقاومتها لمرور الهواء وبالتالي تحديد صنفها ، حسب المواصفات القياسية البريطانية. BS 5368: Part I

- النوافذ والأبواب والواجهات الزجاجية غير القابلة للفتح والإغلاق

يجب أن لا تزيد كيمة الهواء المتسربة من خلال النوافذ والواجهات الزجاجية غير القابلة للفتح والإغلاق عن متر مكعب واحد فى الســـاعة لكل متر طولي من حاصـــل جمع طول المحيط المرئي والقوائم

والعوارض الوسطية إن وجدت ، وذلك عند فحصها حسب المواصفات القياسية البريطانية (BS 5368: Part I).

2) إختبارات نفاذية الماء

يجب أن لا يحدث أي تسرب للماء من خلال النوافذ والواجهات الزجاجية عند تعرضها للمياه تحت ضغط ساكن يعادل (100) نيوتن للمتر المربع الواحد ، وذلك عند فحصها حسب المواصفات القياسية البريطانية (BS 5368: Part 2).

3- التنفيذ

3-1 عام

أ. يتم تصنيع الأبواب والنوافذ حسب المقاسات من قبل فنيين مهرة لهم خبرة بهذا المجال وبالطريقة التي تضمن حسن تنفيذ الأعمال ، يحبث تكون الوصلات متينة بما يكفى لضمان جساءة الأبواب والنوافذ وذلك بإستعمال مرابط داخلية لجمع تلك الوصلات بشكل متقن بما يضمن كتاميتها للماء والهواء ، مع مراعاة أن تكون الزوايا كافة مربعة والأضلاع المتناظرة متوازية.

ب. الأشكال المربعة الشكل على المخططات للأبواب والشبابيك يجب أن تكون مربعة الشكل بالتنفيذ مع مراعاة مساحات التيوبات والمقاطع ، على ذلك يجب أخذ بعين الإعتبار عند إعداد وتقديم المخططات التنفيذية.

ج. يحظر تركيب الأبواب والنوافذ قبل الإنهاء التام (التشطيب) لأعمال الفتحة المعمارية من قصارة وتركيب البراطيش وتنظيف وتكحيل وغيرها من الأعمال ، وكذلك التأكد من شاقولية الجوانب وافقية البرطاش والعتب والإستقامة التامة لكل أضلاع المحيط بتفاوت لا يتجاوز (2)ملم/متر طولي.

3-2 التركيب

أ. يتم تركيب إطارات الأبواب والنوافذ بدقة ومتانة بحيث تكون شاقولية ومستوية بطولها كاملا ، بدون إستعمال القوة أو إحداث أي فتل أو تقوس أو إلتواء بها ، والإ فيحب على المقاول نزعها من مكانها وإستبدالها بأخرى جديدة.

ب. يتم تثبيت حواف وإطارات الألمنيوم إلى السلاحات والبراطيش والقموط بإستعمال الدسر المصنوعة من مادة مبلمر البروبلين أو النايلون أو بإستعمال البراغي المصنوعة من الألمنيوم أو الفولاذ عديم الصدأ، على أن تكون تلك البراغي بالحجم والطول الكافيين لتثبت الحلق بالمتانة المطلوبة وبموافقة المهندس.

ج. تزود مقاطع حلوق الأبواب والنوافذ المنزلقة بثقوب خاصة تسمح بتصريف مياه الأمطار إلى الخارج.

د. يراعى الحرص عند نقل ومناولة أبواب ونوافذ الألمنيوم وذلك لضمان عدم خدش سطوحها أو ثني مقاطعها أو إلتوائها وما شابه ذلك . هذا ويحق للمهندس رفض الأعمال التي تظهر عليها مثل تلك العيوب.

هـ. يحظر وجود تلامس بين سطوح الألمنيوم وأية سطوح معدنية خلافا للفولاذ عديم الصدأ أو الخارصين المغطى بالنكل أو برونز النكل ، إلا بعد معالجة السطوح بإستعمال طلاء تأسيس من كرومات الزنك (Zinc Chromate) ووجه واحد من طلاء الألمنيوم ، أو معالجتها بإستعمال طبقة كثيفة من الطلاء البيتوميني المقاوم للقلويات(Alkali Resistant) .

و. تعالج سطوح الألمنيوم التي سيكون لها تماس مباشر بالسطوح المصنوعة من الخرسانة أو الملاط أو الحجر أو الطوب أو الخشب وما شابهها ، وذلك بطلاء تلك السطوح بطبقة كثيفة من طلاء بيتومين مقاوم للقلويات أو ميثاكريلي (Water-White Methacrylate Lacquer) .

ز. تعبأ الفراغات بين حلوق الألمنيوم والفتحات المعمارية للأبواب والنوافذ بمادة خاتمه من معجون لدن أساس أكرليكي يتم حقنها من الداخل والخارج حسب الأصول وبالكمية الكافية لضمان كتامية تلك الفراغات. كما يجب إستعمال معجون السيليكون (Silicone) الشفاف للغاية ذاتها للحلوق التي توجد في الجدران المبلطة كالمطابخ والحمامات وغرف الغسيل وما شابهها.

ح. يثبت الزجاج إلى إطارات الألمنيوم جيدا وبشكل محكم بإستعمال إطار من النوع المطاط على شكل حرف Uمع مراعاة ما ورد بهذا الخصوص فى قسم أعمال الزجاج من هذه المواصفات.

ط. بعد إنهاء أعمال التركيب يتم معايرة الأبواب والنوافذ بحيث تغلق بسهولة وإتقان.

3-3 تركيب المعجونة

أ.يتم تنفيذ طبقة الأساس وخلط مكونات المعجونة وتنفيذها وفقا لتعليمات الشركة الصانعة.

ب.يتم وضع المعجونة بواسطة حاقن ميكانيكي ذي فوهة بمقاس مناسب لعرض الفاصل وتدفع بقوة داخل المجرى بالضغط.

ج. يجب أن يكون سطح المعجونة ناعما ومستويا ومستمرا بدون إنفصال وخاليا من التجعدات.

د. يتم تنظيف المسطحات المجاورة للفواصل وسطح مادة المعجونة المنفذة من التلوثات والأوساخ الأخرى.

4-3 الحماية والتنظيف

أ. على المقاول حماية أعمال الألمنيوم المركبة كافة من أي تلف أو خدش أو رشق وذلك بوضع الأشرطة اللاصفة المناسبة من النايلون اللاصق على مقاطع الألمنيوم وعلى المقاول أن يستبدل القطع التي يلحق بها الضرر نتيجة لعدم تقيده بهذا الشروط وعلى نفقته الخاصة.

ب.يجب تنظيف أعمال الألمنيوم من آثار المعجونة والأوساخ والزيوت ومخلفات التصنيع والتركيب.

خامساً : أعمال القصارة الأسمنتية

1- عـام

1/1 المجال

يغطي هذا القسم كل ما يتعلق بمستوى المصنعية والمواد وجميع ما يلزم لإنهاء أعمال القصارة الداخلية والخارجية والقصارة اسفل سيراميك الجدران باستخدام الإسمنت البورتلاندي العادي

2/1 التقديمات

أ - على المقاول أن يقدم كتالوجات المواد المضافة للخلطات لاعتمادها مسبقاً من المهندس.

ب - على المقاول أن يقدم عينات من الرمل والركام وإجراء الفحوصات المخبرية اللازمة عليه حسب ما هي محددة في قسم أعمال الخرسانة.

جـ - على المقاول عمل عينة نموذجية من القصارة على سطح من البلوك الخرساني بمساحة لا تقل عن 2م2 لإعتمادها من المهندس .

2- الـمنتجات

1/2 المواد الأساسية

أ - الإسمنت :

يكون من الإسمنت البورتلاندي العادي المطابق للمواصفة القياسية ASTM C150 - TYPE I أو المواصفات القياسية الأردنية (م ق أ /30) .

ب - الـركـام :

1- يكون من الرمل الطبيعي أو الرمل الناتج من سحق الحجر الرملي أو الحصى الرملي. ويجب أن يكون هذا الرمل متماسكاً وخالياً من المواد اللاصقة كالطمي أو من أي كمية يمكن ملاحظتها من الكريات الطينية .

2- يجب أن لا تتعدى كميات الطين والطمي والتراب نسبة 5% من وزن الرمل أو مسحوق الحصى ونسبة 10% من وزن مسحوق الحجر الرملي .

3- يكون التدرج الحبيبي للرمل حسب الجدول (1/7) فقرة 1/702/ج -2 صفحة (7-2) من المواصفات الفنية العامة .

جـ - المـــاء :

يكون مطابقا" لما ورد بهذا الخصوص في قسم أعمال الخرسانة .

د - المواد المضافة :

1- الملدنات (PLASTICIZERS) : تستخدم لكافة خلطات القصارة وتكون الملدنات مطابقة للمواصفة القياسية BS4887 أو ASTM-C494، تستخدم بعد موافقة المهندس المسبقة وتكون من إنتاج الشركات التالية أو ما يعادلها من الشركات الأخرى .

الشركة : فيب ماستر بلدرز - FEB - MASTER BUILDERS

المنتج : RHEOMIX - 720

أو

الشركة : فوسروك FOSROC

المنتج : CEBEX 112

أو

الشركة : SIKA

المنتج : SIKANOL-M

2- المواد المانعة للرطوبة WATERPROOFING ADMIXTURES : تستخدم لطبقات القصارة الخارجية وقصارة خزانات الماء وأحواض الزهور وتكون من إحدى المواد المبينة أدناه إنتاج الشركات التالية أو ما يعادلها .

الشركة : FEB-MASTER BUILDERS

المنتج : RHEOMIX-141

أو

الشركة : FOSROC

المنتج : CONPLAST PROLAPIN 031

أو

الشركة : SIKA

المنتج : SIKA-1 / SIKALITE

أو

الشركة : ديترمان الألمانية

المنتج : سيرانول DM20

2/2 الشبك المعدني والزوايا :

أ - الشبك المعدني : يكون من النوع الممدد ومن الجلفنايزد مطابق للمواصفة القياسية BS 1369 أو المواصفة القياسية الأمريكية ASTM-C847 سماكة لا تقل عن 0.5 ملم وتستخدم الأنواع التالية :

1- الشرائح الشبكية (Strip Mesh): لتقوية القصارة فوق التمديدات والزوايا الداخلية ومناطق اتصال جدران البلوك مع الخرسانة وتكون الشرائح بعرض لا يقل عن 20سم وذات فتحات معينية (DIAMOND) الشكل بمقاس لا يزيد عن12×25ملم ووزن لا يقل عن 1.2كغم/م2.

2- زوايا التقوية (CORNER BEAD) : لتقوية الزوايا الخارجية وتستخدم لتكوين زوايا حادة وتتكون من انف معدني مستدير وجناحين من الشبك المعدني الممدد لا يقل طول كل جناح عن 40 ملم.

3- زوايا إنهاء وحد القصارة (PLASTER-STOP BEAD) : وتستخدم عند مناطق انتهاء القصارة أو لتكوين فاصل تمدد أو فاصل تحكم وتتكون من ضلع معدني بشكل حرف U صغير وجناح من الشبك المعدني الممدد بعرض لا يقل عن 50ملم وبسماكة كلية تساوي سماكة طبقة اللياسة .

4- زوايا إنهاء القصارة حول إطارات الأبواب : تكون كالبند السابق (3) ولكن يكون الضلع على شكل حرف U بكامل السماكة وينتهي بقطعة جانبية من الصاج وتستخدم هذه الزوايا في حالة عدم وجود كشفات (حليات) للأبواب .

5- باقي أنواع الشبك المعدني المستخدم مثل الشرائح الشبكية للزوايا و الألواح الشبكية والألواح الشبكية المضلعة تكون حسب ما هي موصوفة في الفقرة 1/702/و من المواصفات العامة .

ب - المثبتات والمسامير : تكون من المعدن المجلفن ومسطحة الرأس .

3/2 خلط مواد القصارة :

أ - يتم الخلط وتحضير الخلطات وفقا" للمواصفة القياسية ASTM C926 .

ب - تضاف المواد الملدنة والمواد الإضافية حسب تعليمات الشركة الصانعة .

ج - يتم الخلط حسب الكمية اللازمة للاستخدام وبالنسب المحددة .

د - تخلط المواد وهي جافة بشكل كامل حتى الحصول على اللون المتجانس وبعد ذلك يضاف الماء.

هـ - تحمى الخلطات من الصقيع والتجمد .

4/2 طبقات القصارة :

أ - القصارة الداخلية العادية : تتكون من ثلاث طبقات بسماكة كلية 2- 2.5سم هي :

1- طبقة الطرطشة (المسمار) : تكون من الإسمنت والرمل بنسبة حجمية 2:1 .

2- طبقة البطانة (الخشنة) : تكون من الإسمنت والرمل بنسبة حجمية 4:1 مع المواد الملدنة.

3- طبقة الضهارة (الناعمة) : تكون من الإسمنت والرمل الناعم بنسبة حجمية 4:1 مع المواد الملدنة.

ب - القصارة الخارجية : تتكون من ثلاث طبقات بسماكة كلية 2.5سم هي :

1- طبقة الطرطشة : النسب بالحجم 2:1 .

2- طبقة البطانة : النسب بالحجم 3:1 مع الملدنات والمواد المانعة للنش .

3- طبقة الضهارة : النسب بالحجم 4:1 مع الملدنات والمواد المانعة للنش .

ج - القصارة الخارجية : قصارة حسب مواصفات الشركة الصانعه، للواجهات الخارجية المعرضة للعوامل الجوية تطبق فوق القصارة الناعمة بسماكة لا تقل عن 2 ملم.

ه - القصارة اسفل طبقات سيراميك الجدران : تتكون من طبقتين هما طبقة الطرطشة وطبقة البطانة ونسب الخلط لها حسب ما هو محدد في الفقرة (أ) أعلاه .

3- التنفيذ

1/3 عام

أ - يعتمد ما ورد في المواصفات الفنية العامة بند 6/702 صفحة 7-6 بالنسبة للقصارة العادية وبند 7/702 بالنسبة للقصارة على الشبك المعدني والبند 704 / 5 صفحة (7-15) بالنسبة للقصارة الخارجية مع الأخذ بعين الاعتبار طبقات القصارة ونسب الخلط المطلوبة المحددة أعلاه.

ب- يتم الالتزام بالشروط العامة لأعمال القصارة الواردة في البند 707 من المواصفات العامة بما لا يتعارض مع الوارد في هذه المواصفات .

ج - يتم عمل الودعات ونقاط تحديد الاستقامة الأفقية والرأسية حسب ما هو محدد في المواصفات الفنية العامة وحسب تعليمات المهندس .

د- يكون ارتفاع الشرائح والزوايا المعدنية المستعملة في القصارة بكامل ارتفاع الطابق أو بكامل العرض في حالة التقاء جدران الطوب مع السقف أو الجسور الساقطة، وفي حالة الشرائح المعدنية المستخدمة ما بين القموط الخرسانية وجدران الطوب تكون بكامل طول القمط.

و- أسعار أعمال القصارة بكافة أنواعها تشمل المواد المضافة والشبك المعدني بكافة أنواعه حسب الاستخدام المحدد لكل نوع وتشمل تخشين الأسطح الخرسانية الناعمة (إن وجدت) وتشمل العمل في كافة الأماكن والأشكال والمناسيب وعمل الفرزات والزوايا والأماكن الضيقة والصغيرة والنيش والسلاحات والقموط والأعمدة والأقواس والأسطح المنحنية مهما كانت .....الخ .

سادساً : أعمال الإنهاء – أعمال الدهان

1- عـــــام

1/1 المجال

أ - يغطي هذا القسم كل ما يتعلق بوحدات التصنيع ومستوى المصنعية وإنجاز كل العمليات ذات الصلة بأعمال الدهان بكافة أنواعه وأماكن استخدامه المختلفة على الأسطح الخرسانية والإسمنتية وأسطح ألواح الجبس ودهان الأعمال الخشبية والمعدنية حسب ما هو محدد في المخططات وهذه المواصفات.

ب- لا يغطي هذا القسم دهان الأعمال التالية ولا يطلب من المقاول دهانها :

1- الخرداوات المدهونة بالمصنع ما لم يرد خلاف ذلك في موقع آخر .

2- الأسطح من الستانلس ستيل أو الأسطح غير المعدنية ما لم يرد خلاف ذلك في موقع آخر.

3- الأسطح والعناصر والأجهزة والمعدات المدهونة مسبقا" في المصنع .

2/1 مطابقة المواصفات

أ - يجب أن تكون كافة مواد الدهان مطابقة للمواصفات القياسية الأردنية ذات العلاقة على الأقل ومحققة إضافة على ذلك لكافة المواصفات الواردة هنا .

3/1 التقديمات

أ - على المقاول تقديم كتالوج كافة المواد الداخلة في الأعمال متضمنا" المواد والمواصفات والتركيب وكافة المعلومات اللازمة حسب ما تصدر عن المصنع .

ب- على المقاول تقديم نماذج وعينات مدهونة للاعتماد من المهندس لكافة أنواع الإنهاء ولكافة المواد (خرسانة، سطح لياسة، خشب، حديد) وتكون العينات بالقياس المناسب وبالمواد المطلوبة في هذا المشروع.

جـ- على المقاول تقديم شهادة فحص مخبرية تؤكد مطابقة المواد المنوي استخدامها للمواصفات المذكورة.

4/1 التوريد والتخزين

أ - يتم توريد مواد الدهان إلى الموقع في العبوات الأصلية وتكون جديدة وغير مفتوحة ومسجل عليها شعار واسم الشركة المنتجة وتتضمن المعلومات التالية:

1- اسم المنتج.

2- المواصفة القياسية التي تنطبق عليها هذه المادة.

3- معلومات التخزين وتاريخ الصنع ورقم الخلطة.

4- المحتوى بالحجم او الوزن.

5- تعليمات الدهان والاستعمال.

6- اسم ورقم اللون.

ب- تخزن الحاويات والعبوات في مخزن الدهان في موقع نظيف وخالي من المواد الغريبة وشروط تخزين حسب تعليمات الشركة الصانعة ويتم حماية المواد من الصقيع والرطوبة والزيوت .

5/1 شروط العمل في الموقع - JOB CONDITIONS

أ - يتم تنفيذ أعمال الدهان فقط عندما تكون درجات الحرارة للأسطح المراد دهانها والجو المحيط فيها بين 8-40 درجة ما لم ينص على خلاف ذلك في تعليمات الشركة الصانعة .

ب- يمنع القيام بالدهان في الثلوج، تحت المطر، أو على الأسطح المبللة .

جـ- يجوز الدهان في الأجواء الباردة فقط إذا تم رفع درجة حرارة الغرفة في الموقع المراد الدهان فيه عن طريق التدفئة على أن لا تقل درجة الحرارة عن المذكور أعلاه فقرة أ.

2- المنتجات

1/2 طبقات الدهان

أ - لغايات هذه المواصفات تقسم طبقات الدهان للسطوح الإسمنتية والخشبية والمعدنية وأسطح ألواح الجبس وما شابهها إلى ما يلي :

1- الطبقة التأسيسية (PRIMER) .

2- طبقة البطانة (UNDERCOAT) .

3- طبقة الضهارة (FINISHING) .

ب- على المقاول تسليم كل طبقة دهان أو معجونة إلى المهندس والحصول على موافقته الخطية عليها قبل المباشرة بأعمال الطبقة التالية.

جـ- يحدد عدد طبقات الدهان لكل نوع حسب الوارد أدناه في هذه المواصفات وهذه الطبقات تمثل الحد الأدنى وعلى المقاول زيادة عدد طبقات الدهان على حسابه الخاص حتى الحصول على التغطية الكافية.

2/2 مواد المعجونة (PUTTY)

أ - عام :

تكون المعجونة في جميع الحالات من النوع الجاهز ومن إنتاج نفس الشركة المصنعة لمواد الدهان الأخرى ويتم اختيار النوع المناسب حسب موقع الاستخدام وتوصيات الشركة الصانعة.

ب- معاجين السطوح الإسمنتية :

تكون من المواد اللاصقة البلاستيكية (ACRYLIC) مع المواد المالئة، ذات أساس مائي، وتتميز بقوة التماسك والقدرة على التغطية وسد الشقوق.

جـ- معاجين السطوح الخشبية واسطح الجبس :

تكون مطابقة للمواصفة القياسية البريطانية BS 544 مكونة من مواد لاصقة بلاستيكية مع مواد مالئة مناسبة للسطوح الخشبية .

د - عدد طبقات التبطين بالمعجونة المطلوبة :

طبقة عدد (2) طلس بالإضافة إلى طبقات التفقيد بين اوجه وطبقات الدهان المختلفة ما لم يحدد خلاف ذلك في هذه المواصفات .

3/2 دهان الاملشن الاكرليكي (البلاستيكي)

أ - يكون الدهان الاملشن من الأنواع المصنعة من احدث مركبات الاكريليك النقي (PURE ACRYLIC) ومقاوم للأشعة فوق البنفسجية ومقاومة الغسيل اكثر من 15000 حكة أو دورة عند فحصه حسب المواصفة الأمريكية ASTM-D-2486 .

ب- يكون الدهان الاملشن عالي الجودة ومن الأصناف التي تتنفس أي تسمح بنفادية البخار من خلاله ولا تسمح بمرور الماء .

جـ- يكون الدهان الاملشن المستخدم مصنوع خصيصاً لمقاومة القوة المتلفة في الحوامض والمواد القلوية والرطوبة والعفن والبقع الناتجة من التأكسد وتغيير اللون ولا يتغير بتقلبات الجو .

د - يكون الدهان الاملشن عديم اللمعة .

هـ- يجب إن لا يحدث تغيير على لون الدهان إذا ما عرض للشمس .

و - يكون الدهان الاملشن مقاوم للعفن .

ز - تكون نسبة المواد اللاصقة الصلبة لا تقل عن 13% ونسبة ثاني اكسيد التيتانيوم لا تقل عن 20% وزناً.

ح - تكون طبقة دهان الاساس من النوع المقاوم للقلويات وذات قدرة عالية على التغطية وسد المسامات ومن الأنواع المناسبة التي توصي بها الشركة الصانعة لمواد الدهان .

ط- أماكن الاستخدام : للأسطح الخرسانية والاسمنتية واسطح ألواح الجبس والكرانيش الجبسية واسطح خرسانة GRC وحيثما يلزم حسب تحديد جداول الكميات والمخططات .

ي- طبقات الدهان المطلوبة بعد تحضير الأسطح للدهان :

1- طبقة تأسيس بمادة مقاومة للقلويات بعد الحف الجيد باستخدام مواد مثل البولي يوند الإنجليزي.

2- طبقتين معجونة طلس مع الحف الجيد ويشترط تسليم كل طبقة معجونة إلى المهندس المشرف وموافقته عليها .

3- طبقة دهان بطانة (عدد 2) مع التفقيد بالمعجونة بين كل وجه .

4- طبقة دهان ضهارة مع التفقيد بالمعجونه .

5- أي عدد آخر من طبقات الدهان للحصول على التغطية اللازمة .

4/2 الدهان الديكوري مع بزرة للاسطح الخارجية

أ - يكون الدهان من النوع المقاوم للرطوبة والعفن والظروف الجوية وتقلباتها ، مرن ، مطابق للمواصفة القياسية الأردنية ويحتوي على نسبة عالية من المواد البلاستيكية الاكريليكية (PURE ACRYLIC) مع المواد الملونة والمالئة وحبيبات الرمل الناعمة وله الخواص التالية :

1- نسبة المواد الصلبة وزنا" %60

2- نسبة المواد اللاصقة الصلبة %35

3- مرن ودائم المرونة

4- مقاوم للرطوبة والعفن

5- الحبيبات الرملية من كسر الرخام ورمل السيلكا

6- عالي الجودة

7- له خاصية تغطية ومعالجة التشققات

ب- على المقاول أن يقدم شهادة فحص للدهان تؤكد مطابقته للمواصفات المذكورة أعلاه، بالإضافة إلى شهادة الضمان لمدة 5 سنوات من المصنع .

جـ- تكون البزرة بين العادي والخشن حسب اختيار المهندس .

د - يتم دهان طبقة الأساس حسب تعليمات الشركة الصانعة .

هـ- أماكن الاستخدام : الأسطح الخرسانية والإسمنتية الخارجية وحيثما يلزم حسب تحديد جداول الكميات.

و- طبقات الدهان المطلوبة بعد تحضير الأسطح للدهان :

1- تعبئة الشقوق بمادة مالئة اكريليكية .

2- دهان طبقة الأساس .

3- طبقة دهان نهائية مع بزرة .

4- أي طبقات دهان إضافية للحصول على التغطية اللازمة .

3- التنفيذ

1/3 عام

أ - يعتمد ما ورد في الفقرات 1306 و 1308 من كتاب المواصفات العامة لتنفيذ المباني بخصوص إعداد المواد والنظافة والأحوال المناخية والتطبيق وتحضير الأسطح للدهان مع مراعات ما يرد في المواصفات الواردة هنا ولها الأولوية في التطبيق .

ط- تكون طريقة تطبيق الأصباغ الزيتية باستعمال الفرشاة المصنوعة من الشعر الخشن (BRISTLE) الطبيعي .

ي- يمكن استعمال طريقة الدهان بالرش لجميع أنواع الأصباغ المائية والكحولية والزيتية .

ك- بما أن عدد اوجه الأصباغ يؤثر على درجة قتامة اللون، لذا فإنه يجب أن تتم علمية التطبيق بسحبات منتظمة مع عدم تراكب تلك السحبات. هذا وتتم عمليات الصبغ على السطوح المستوية أولاً ثم على الحواف والزوايا وما شابهها .

4/3 دهان السطوح الإسمنتية

أ - إعداد السطوح :

1- في حالة وجود جيوب هوائية أو ثقوب أو تعشيش أو ما شابهها من عيوب في السطوح الخرسانية الملساء أو سطوح اللياسة أو أي سطح خرساني يراد طلاؤه، تعالج سطوحها والخرسانة لا تزال في الحالة الرطبة باستخدام معجون يفضل أن يكون إسمنتياً أو إسمنتياً لاتكسيا. وتتم المعالجة بتوسيع اماكن الثقوب والفراغات وغيرها من العيوب في السطح الخرساني وتعبئتها بالمعجون ثم تركها لتجف تماماً، أو تعبئتها باستخدام المالج ومن ثم فركها بالممسحة المطاطية حتى الحصول على سطح مستو املس تماماً. يجري بعد ذلك ايناع وترطيب السطوح المعالجة بشكل جيد لعدة أيام متتالية بحيث يبقى المعجون خلالها رطباً بشكل مستمر.

2- تترك السطوح لتجف تماما" قبل تنعيمها بالورق المرمل أو حجر الكاربوندم وقبل المباشرة بأعمال الدهان.

ب- الطلس (التبطين) بالمعجون :

1- يطلى السطح بالكامل بدهان تأسيسي مقاوم للقلويات ثم يغطى ويبطن بالمعجون كاملاً حسب الأصول.

2- ينعم السطح باستعمال الورق المرمل الناعم حسب الأصول وحتى درجة النعومة المطلوبة وذلك بعد جفاف المعجون تماما" .

3- يدهن طبقة دهان أساس ثانية فوق الطبقة الأولى من المعجونة .

4- يغطى ويبطن السطح بطبقة ثانية من المعجونة على كامل المساحة وينعم السطح بعد ذلك حسب ما ورد في بند 2 سابقاً.

5- يتم بعد ذلك تفقد السطح بالمعجون وتنعيمه للأماكن التي تبدو عليها خشونة قد تؤثر على جودة وجه الدهان النهائي، بحيث يصبح خاليا" من العيوب كافة، واملس تماماً لإجراء أعمال الدهان عليه.

جـ - دهان السطوح الإسمنتية :

1- تكون السطوح جافة تماما" وخالية من بقايا الملاط والغبار والأملاح المتزهرة وخلافها وذلك قبل المباشرة بدهانها .

2- تطلى السطوح بطبقات الدهان المطلوبة المحددة في هذه المواصفات .

3- تتم عمليات دهان السطوح بطبقتي البطانة والظهارة حسب تعليمات الشركة الصانعة وهذه المواصفات.

5/3 شروط خاصة للتنفيذ

أ - يحظر تخفيف الدهان بالمواد المخففة أو الزيوت أو الماء، أو إضافة مواد أخرى له كالأسبيداج أو الخضاب مثلا" ومهما كانت الأسباب إلا إذا سمحت تعليمات الشركة الصانعة بذلك وبموافقة المهندس.

ب- يحظر استعمال الدهان الذي يحتوي داخل عبواته المختومة على أية مواد مترسبة أو تترسب أثناء الاستعمال.

جـ- يجب على المقاول تقديم السقالات والسلالم والعدد والأدوات الضرورية وخلاف ذلك مما يضمن إنجاز الأعمال على أكمل وجه ويحافظ على سلامة العاملين والسلامة العامة .

د - تنفذ أعمال الدهان من قبل فنيين ذوي خبرة في هذا المجال، ويحق للمهندس الطلب من المقاول أن تجرى أمامه الاختبارات التي تثبت كفاءة أولئك الفنيين لتنفيذ الأعمال المطلوبة وعلى نفقة المقاول الخاصة.

هـ- يجب على المقاول المحافظة على نظافة الأعمال الأخرى نظافة تامة ويشمل ذلك الأرضيات والتمديدات الكهربائية والصحية والتدفئة المركزية وخلافها، ويتم ذلك بتغطية تلك الأعمال مقدماً حسب الأصول باستعمال رقائق البولي اثيلين، والاشرطة اللاصقة والشوادر والخيش وخلاف ذلك. هذا، وان التزام المقاول بتنظيف كل الأعمال الأخرى من آثار أعمال الدهان، لا يعفيه من الالتزام بما ورد في هذا البند.

TECHNICAL SPECIFICATION
ELECTRICAL SERVICES

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Annex	**APPROVED MANUFACTURERS LIST**

General Notes

1. The locations and dimensions of all electrical, instrument, control, and communication equipment are shown in drawings for indicative purposes, final positions are to be confirmed with the APC team.

2. Underground ducts and manholes work shall be conducted based on-site survey by the contractor that shall provide exact rout and quantities for APC engineer based on the shop drawings that shall be generated from his side before material procurement or starting work, the contractor shall notify APC engineer if the quantities are increased accordingly.

3. The construction of the crossing road duct bank shall be given high priority so that it shall be completed within 3 days max. Provided that no interruption for transportation on the road and providing traffic safety signs where required.

4. The contractor shall observe and comply with safety regulations enforced by the employer on working at the new and existing electrical network.

5. The contractor shall submit & supply the data switches in the beginning to avoid any delay in the project handover (these notes shall be applied with all material submittals that are expected to cause delay in the project handover)

SECTION – 16060
GROUNDING AND BONDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding System including, but not limited to the following:

1. Grounding rods.
2. Grounding conductors.
3. Grounding connection bar.
4. Grounding of various systems.

1.02 RELATED SECTIONS

A.	Section 16050	Common Electrical Work Results, General.
B.	Section16075	Identification for Electrical Systems.
C.	Section 16120	LV Electrical Power Conductors and Cables.
D.	Section 16134	Underground Electrical Services.
E.	Section 16910	Operation, Maintenance and Testing/Commissioning of Electrical Systems

1.03 REFERENCES

A.	British Standard Code of Practice CP1013 - Grounding.	
B.	BS 7671	IEE Wiring Regulations, 17th Edition.
C.	IEC	International Electromechanical Commission

1.04 SUBMITTALS

A. Product

B. Data: Submit data on grounding electrodes and connections.

C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

D. Manufacturer's Installation Instructions: Submit for active electrodes.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Provide grounding, surge protection and lightning protection of Electrical system in accordance with latest version of Grounding, Bonding and Electrical Protection chapter of the BS & IEC.

B. Maintain one copy of each document on site.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE AND HANDLING

A. Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.08 COORDINATION

A. Complete grounding and bonding of building reinforcing steel prior concrete placement.

1.09 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 PRODUCTS

2.01 GENERAL

All the materials required for Grounding system shall be furnished new and undamaged in accordance with the requirement stated in this section.

For grounding pits shall be installed as per Local Electric Supplier Requirements, which will be isolated from the main Grounding loop.

Underground direct buried 1x 95 mm^2 stranded bare copper cable install at 700 mm FFL for grounding and bonding as shown on drawing.

2.02 GROUNDING RODS (WHERE APPLICABLE)

A. Grounding rods shall conform to BS requirements.

B. Grounding rods shall be copper-clad steel 14.2 mm diameter with min. 1200mm length. For extra lengths, rods shall be coupled together using threaded copper alloy couplings.

C. The terminal end of grounding rod shall finish 300mm below finished ground level covered by a concrete inspection sealed pit of size 300mmX300mm with concrete cover that can withstand 1200Kg load rating.

D. Grounding electrodes for each system shall have an interconnected resistance to Grounding of not more than 2 Ohms. Where this value is exceeded, it shall be augmented by additional electrodes connected in parallel spaced at approximately four meters apart until this value is reached.

2.03 GROUNDING CONDUCTORS

A. Size of Grounding conductors shall be as shown on the drawings and in accordance with the applicable standards.

B. Grounding conductors shall be as follows:

1. Outdoor underground: Soft drawn bare high conductivity annealed plain stranded copper conductor.
2. Inside building: Same as for outdoor conductor but with green/yellow colored polyvinyl chloride (PVC) insulation.

C. PVC insulated copper conductor cable shall be used for final connections from grounding loop to structures, equipment, etc and for Grounding/bonding of equipment and metalwork inside the building.

D. All copper to copper connections, splices, taps, etc. in conductor and at the accessories for termination shall be made by the exothermic weld process. Joints for underground installation shall be epoxy resin encapsulated before burial.

E. The Grounding conductor in the conduit shall be continuous through the conduit run with bushing Grounding connection and terminated on the panel board Grounding.

2.04 GROUNDING CONNECTION BAR

A. Each Grounding connection bar shall have a permanent label to identify the connections together with the wording "Main Grounding Bar".

PART 3
EXECUTION

3.01
INSPECTION

A. Examine the area and conditions under which the Grounding systems are to be installed and correct any unsatisfactory conditions detrimental to the timely and proper completion of the work. Do not proceed with the work until the conditions are satisfactory in a manner acceptable to the Engineer.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. The installation shall be carried out in accordance with IEE Wiring Regulations, 17th Edition. The position of all conductors, joints and terminals shall be approved by the Engineer prior to commencing the work.

B. All electrical equipment shall be connected to the Grounding with copper Grounding conductor. The term "electrical equipment" shall include all metal enclosures containing electrical connections or bare conductors. Individual devices such as solenoids, pressure switches, and limit switches shall be exempt from this requirement unless the device requires Grounding for proper operation. Large equipment such as power distribution board or motor control centers shall be furnished with a Grounding bus, which shall be connected at two points to the Grounding. All Grounding connection surfaces shall be cleaned immediately prior to connection. Provide all Grounding material required but not furnished with the equipment.

C. All exposed non-current carrying metallic parts of all the installations shall be effectively grounded. The steel conduit systems, metallic equipment enclosures, metallic lighting fixtures, cable trays, all non-current carrying metal parts of electrical systems and any other equipment or system components shall be grounded and the connection shall be extended to the nearest panel board Grounding or grounding bar in sub-station.

D. The conductive sheaths and armor of cables shall be connected to grounding.

E. All connections and joints for the grounding system including bonding connections shall be made using "Exothermic" process which produces a fused joint.

3.03 GROUNDING RODS INSTALLATION

A. All grounding rods shall be installed at suitable locations and to the depth to achieve required resistance. Where the grounding rod length exceeds 2.5 m, standard sections shall be connected with aluminum bronze coupling to extend the rod.

B. Grounding rods shall be driven with a cap driving stud.

C. All connections between rods and grounding conductors shall be made by removable bolted connection.

D. All grounding rods shall have inspection pits as shown on Drawings. The pit shall be constructed from pre-cast concrete. All connections to the grounding rod shall be exposed when the cover is raised. Attach a "DANGER - ELECTRICITY" sign to the wall of the inspection pit. Use English and Arabic white letters on red background. Inspection pit cover shall be constructed from cast iron.

3.04 GROUNDING CONDUCTORS INSTALLATION

A. Standard sizes of stranded copper conductor used for Grounding continuity shall be according to the requirements of IEE Wiring Regulations, 17th Edition.

B. Suitable Grounding facilities, acceptable to the Engineer, shall be furnished on electrical equipment to consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

C. The conduit system shall not be considered as continuous for Grounding purposes. A separate Grounding conductor shall be installed in the same conduit with the phase and neutral conductors. The separate Grounding conductors shall be sized according to IEE Wiring Regulations, 17th Edition Requirements. No Grounding conductors shall be smaller than 4.0 mm^2 unless this is part of a multicore cable. Where flexible connections are made to equipment, Grounding jumpers shall be provided. All connections of heavy gauge steel conduit system shall be checked for good electrical continuity.

D. Exposed conductors shall be installed inconspicuously in vertical or horizontal positions on supporting structures. When located on irregular supporting surfaces or equipment, the conductors shall run parallel to or normal to the dominant surface.

E. Conductors routed over concrete, steel or equipment surfaces shall be kept in close contact with those surfaces by using fasteners located at intervals not exceeding 1 m.

F. Exposed Grounding conductors shall be securely fastened to the mounting surface using copper or brass straps.

G. Clamps, connectors, bolts, washers, nuts and other hardware for bolted connection to Grounding system shall be of copper.

H. Exothermic welds shall comprise moulds, cartridges, materials, and accessories as recommended by the manufacturer.

I. The Grounding conductors entering the building shall be installed in a 25 mm diameter PVC conduit. Waterproofing shall be provided at all entry of Grounding conductors, details of which shall be approved by the structural engineer.

J. Grounding conductors shall be buried at a minimum depth of 750 mm below finished grade.

K. Underground conductors shall be buried in clean sifted Grounding.

L. Except for sub-stations and electric rooms, the exposed Grounding conductor shall run in protective pipes for runs below 900 mm from floor level. Pipe shall also be provided at locations where conduct is likely to be subject to physical damage.

M. Extensions from Grounding loop as shown on the Drawings shall be provided for connection to electrical equipment. Connect the Grounding conductor to the equipment, Grounding bus, pad or lug. In addition to the Grounding grid extension conductors, a Grounding cable to each end of the Grounding bus in each assembly of power distribution board or panel boards shall be provided.

N. Where a Grounding conductor is included with the phase conductors of power circuits, the Grounding conductor shall be connected to the equipment Grounding facilities and to the source Grounding bus. Where a grounding conductor is not included with the phase conductors, the equipment shall be grounded by

connecting a separate Grounding cable to the equipment Grounding facilities and to the tray Grounding cable or source Grounding bus. Except where otherwise shown on the Drawings, integral parts of a cable assembly shall be sized in accordance with the requirements of IEE Wiring Regulations, 17th Edition.

3.05 GROUNDING LOOP IMPEDANCE

A. The completed Grounding system shall have sufficiently low impedance to limit the voltage to grounding and to facilitate the operation of the current protective devices in the circuit. Grounding loop impedance shall not exceed the values specified in BS or other applicable standards.

3.06 BUILDING SYSTEMS GROUNDING

A. The building low current systems including communication, control and alarm functions...etc shall be provided with Grounding as shown on the Drawings and in relevant specifications.

B. The installation of the Grounding for building systems shall be in accordance with the recommendations of standards, and the applicable provisions of this section.

3.07 SUPPLEMENTARY AND EQUI-POTENTIAL BONDING

A. In accordance with Section 547 of the IEE Wiring Regulations 17th Edition (BS 7671) bonding conductors shall be installed in appropriate locations to ensure all simultaneously accessible exposed or extraneous conductive parts are at equal potential. Undertake such tests and install such supplementary bonding conductors that are necessary to ensure compliance with these requirements.

B. Supplementary bonding conductors shall conform to the requirements of Section 547-03 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 2.5 $mm^2$where mechanically protected and 4.0 mm^2 where not so protected.

C. Main equi-potential bonding conductors shall conform to the requirements of Section 547-2 of the IEE Wiring Regulations and shall have a minimum cross-sectional area of 6.0 mm^2.

3.08 FIELD QUALITY CONTROL

A. Comply with Section 16910.

B. Grounding resistance tests shall be carried out after installation of the individual Grounding systems in accordance with the Specifications. The Grounding resistance tests shall be carried out in accordance with Section 713-11 of the IEE Wiring Regulations 17th Edition and readings obtained officially recorded by all witnessing parties.

C. Prior to connection of Grounding rods to the Grounding system, the Grounding resistance of individual Grounding rod shall be measured by using an approved type of Grounding resistance tester.

D. After completion of all the connections of Grounding system, the Grounding resistance shall be measured from the Grounding test point in presence of the Engineer.

E. All the Grounding resistance test reports shall be submitted for Engineer's approval.

END OF SECTION

SECTION– 16050
ELECTRICAL WORKS, GENERAL

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide electrical work, complete and operable, in accordance with the Contract Documents.

B. They shall be read and interpreted in conjunction with all other Sections of the Specifications, the Drawings, Equipment, Schedules and all other Documents forming parts of the tender package.

C. The provisions of this Section apply to all sections in Division 16, except as indicated otherwise.

D. The WORK of this Section is required for operation of electrically-driven equipment provided under specifications in other Divisions. The CONTRACTOR's attention is directed to the requirement for proper coordination of the WORK of this Section with the WORK of equipment specifications and the WORK of instrumentation sections.

E. All concrete, excavation, backfill, and steel reinforcement work required for encasement, installation, or construction of the work of the various sections of Division 16 is included as a part of the work under the respective sections, including duct banks, manholes, handholes, all related civil works…etc.

F. The electrical system design conditions for the project are:-

Rated Voltage	:	230/400V ± 4%, 3 phase, 5 wire (3 phase+1 neutral + 1 earth)
Neutral	:	Solidly earthed at the source
Frequency	:	50 HZ
Earthing System	:	T-NS
Voltage Drop	:	Max. allowable voltage drop is 4.0% from the source (LV panels) up to the last element of the electrical circuit.

1.2 REFERENCE STANDARDS

A. The WORK of this Section and all sections in Division 16 shall comply with the following as applicable:
- The general and specific requirements of local Power CO. (EDCO).
- The general and specific requirements of the Local Authorities. (Civil Defense Depart (CDD),
- Telecommunication Authority, etc)
- International Electro - technical Commission (IEC).
- The Regulations for the Electrical Installations of Buildings (BS 7671 IEE-17th edition, 2001) issued by the Institution of Electrical Engineers (UK).
- British Standards (B.S.)
- The Buildings Lighting Code issued by the Chartered Institution of Building Services Engineers CIBSE - (UK)

B. Where Local Standards are enforced and relevant, they shall overwrite the above Standards.

1.3 PUBLIC UTILITIES REQUIREMENTS

A. The CONTRACTOR shall contact the electricity utility provider to verify compliance with requirements before construction. The CONTRACTOR shall coordinate schedules and payments for work by all utilities.

B. Electrical service shall be as indicated and be as required by the serving utility.

C. The CONTRACTOR shall verify and provide all service conduits, fittings, grounding devices, and all service wires not provided by the serving utility.

D. The CONTRACTOR shall verify with the utility the exact location of each service point and type of service. The owner will bare the cost of providing the electricity supply from local Power Authority.

1.4 PERMITS AND INSPECTION

A. Permits shall be obtained and inspection fees shall be paid according to General Conditions

B. Unless otherwise required in the Contract The CONTRACTOR shall pay all connection and turn-on service charges required by the utility company.

1.5 SUBMITTALS

A. Contractor Submittals.

1. Submit shop drawings and product data.

2. Indicate system components, size of components, location and provide full schematic diagram of wiring system showing building and operation details.

3. Submit manufacturer's installation instruction.

4. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data.

5. Before completion of the project, submit complete maintenance manual including "As-fitted" drawings product literature, etc.

B. Shop Drawings: Shop drawings shall include the following:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop drawings for all grounding work not specifically indicated.
3. Front, side, rear elevations and top views with dimensional data.
4. Location of conduit entrances and access plates.
5. Component data.
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers.
7. Method of anchoring, seismic requirements; weight.
8. Types of materials and finish.
9. Nameplates.
10. Temperature limitations, as applicable.
11. Voltage requirement, phase, and current, as applicable.
12. Front and rear access requirements.

13. Test reports.
14. Grounding requirements.
15. Catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material. Catalog data sheets shall be stamped to indicate the project name, applicable Section and paragraph, model number, and options.

C. Shop Drawings shall be custom prepared. Drawings or data indicating "optional" or "as required" equipment are not acceptable. Options not proposed shall be crossed out or deleted from Shop Drawings.

D. Equipment: The CONTRACTOR shall deliver to the ENGINEER within 30 days, a complete list of all materials, equipment, apparatus, and fixtures proposed for use. The list shall include type, sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

All equipment to be installed under this contract shall be manufactured by a worldwide well known manufacturers, and the quality of the product shall be of an approved standard, a list of recommended manufacturers is within this volume. A sample must be presented with each equipment / material before installations for approval by the Engineer.

The Contractor must give full details of type and manufacturer. The manufacturers must have local representation capable of supplying spare parts, and giving technical support throughout the working period of the equipment.

The Contractor shall name each material or equipment he proposes to supply for the purpose of this project, supported by all details and technical data.

E. Record Drawings and Manuals: Unless otherwise required in the Contract within Thirty days of the issue of the Certificate of Completion, the Contractor shall provide fully detailed "As Built" Record Drawings for the whole contract works together with full operating and maintenance instructions to be checked and approved by the Engineer. Record drawings shall also be submitted in an electronic soft copy. Temporary manuals and record drawings shall be made available at least one month before to enable the Employer's staff to familiarize themselves with the installation. These should preferably be the final manuals with temporary insertions for the items, which cannot be finalized until the works are completed and tested.

The Drawings shall comprise general arrangement drawings of all installations; detail drawings of plant rooms and similar areas; single line diagrams of all services; line diagrams of control systems; and electrical circuit diagrams.

The Drawings shall indicate the color coding, labeling and identification of all the services as previously described, and shall give full working details of size, load, duty and capacity of each item of plant. The Drawings shall also clearly indicate the location of all vents, drains, dampers, valves and test points. The line diagrams shall indicate the type, location and function of each component and, together with the interconnecting wiring and piping, the terminal connection reference numbers or letter on the actual equipment.

The Drawings shall:-

a. Indicate sizes and positions of all plant, equipment pipes, conduits, trunking, under-floor ducting, cable tray and cables together with all inspection points and cable joints.
b. Indicate the circuit reference for all equipment and each outlet shown. All references shall agree with the charts and labels in distribution boards fixed to the switchgear.

c. Show the disposition and depth of all cables, whether buried direct in ground, drawing through ducts/manholes and house connections to existing service tunnel. The positions of cables, etc.. shall be physically measured from permanent buildings, boundaries or other permanent features.

All changes of cable direction shall be shown.

d. Show the position and nature of all earth electrodes installed and the range of connection copper tapes.

e. In addition to the Record Drawings, the Contractor shall obtain and provide two sets of the manufacturers catalogues, spare parts and detailed drawings of all items of plant, suitably titled and with drawing reference numbers added.

The Record Drawings shall be specially prepared and shall not be modified Working Shop Drawings. The preparation of these Drawings shall proceed during the installation of the Contract Works, as each section is completed. To ensure that this requirement is met, the Engineer shall be allowed to inspect the Drawings on request.

Unless otherwise required in the Contract the Operating and Maintenance Instructions shall be prepared as soon as the working drawings are in hand and shall take the form of a manual in which is described the layout and function of the systems, schedules of components comprising each and every item of equipment including manufacturer's name, reference and serial number and operating maintenance instruction based on the manufacturer's standard instruction-simplified where necessary.

f. An overall maintenance schedule shall be prepared by the Contractor on a system basis, listing out in simple terms the plant, nature of attention and intervals due. This shall be cross-referenced with the manufacturer's standard instructions.

g. Drawings shall be arranged to fold out from their position and be entirely visible when any part of the manual is being read.

The manuals shall be encased in loose lead binders.

All operating instructions and maintenance procedures must be displayed clearly in plant rooms.

The Contractor shall include for the preparation and supply of the required number of copies for the manuals and drawings after all details have been approved by the Engineer.

F. Coordination: The Contractor shall be responsible for all aspects of coordination necessary to ensure that the works are properly installed in accordance with the Contract Drawings and Specifications. This shall include the interrelationship between Mechanical and Electrical Services, Loaded Equipment Layout, the Building Foundations, Fabrics and Finishes, and all Specialist Equipment contained therein, whether supplied under this Contract or not.

G. Coordination shall cover the programming and physical requirements of all works. Particular care must be taken in the setting out of works in common ducts, subways, false ceilings or similar areas accommodating several services. The disposition of services shall be such that necessary segregation is maintained and that the completed installation affords ready access at a later date for the replacement, maintenance and extension thereof.

1.6 AREA DESIGNATIONS

A. General

1. Raceway system enclosures shall comply with Section 16130 - Electrical Raceway Systems.

2. Electric WORK specifically indicated in sections within any Division of the Specifications shall comply with those requirements.

B. Equipment Ratings

All equipment selected for use in this Contract shall be suitable for continuous reliable operation under the design conditions and standard stated. In addition, some equipment installed in closed spaces may be subject to temperatures in excess of those prevailing externally and this shall be taken into account.

Where ratings, are given in this Specification and/or are shown on the Drawings, they are the actual ratings to be achieved after the application of all derating factors.

It should be noted that, where equipment is to be subjected to corrosive conditions it shall be manufactured and protected to withstand the same without undue deterioration. Enclosures must have proper IP protection and suitable material to protect the equipment in such corrosive conditions.

1.7 TESTS

A. The CONTRACTOR shall be responsible for all factory and field tests required by specifications in Division 16 and by the ENGINEER or other authorities having jurisdiction. The CONTRACTOR shall furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of faulty installation.

B. Where test reports are indicated factory performance test reports for custom-manufactured equipment shall be submitted for approval prior to shipment. Field test reports shall be submitted for review prior to Substantial Completion.

C. Any equipment or material that fails a test, shall be removed and replaced.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment and materials shall be new, according to the required standards. All equipment and materials shall be the products of experienced and reputable manufacturers in the industry. Similar items in the WORK shall be products of the same manufacturer. All equipment and materials shall be of industrial grade standard of construction.

B. Where an Ingress Protection (IP) enclosure type is indicated in a non-hazardous location, the CONTRACTOR shall utilize that type of enclosure, despite the fact that certain modifications such as cutouts for control devices may negate the IP rating.

2.2 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. All nuts, bolts, and washers shall be stainless steel.

2. Threaded rods for trapeze supports shall be continuous threaded, galvanized steel, 3/8" diameter minimum.

3. Where contact with concrete or dissimilar metals may cause galvanic corrosion, suitable non-metallic insulators shall be utilized to prevent such corrosion.

4. Anchors for attaching equipment to concrete walls, floors and ceilings shall be stainless steel expansion anchors. Wood plugs shall not be permitted.

2.3 ELECTRICAL IDENTIFICATION

A. Nameplates: Nameplates shall be fabricated from white-letter, black-face laminated plastic engraving stock. Each shall be fastened securely, using fasteners of brass, cadmium plated steel, or stainless steel, screwed into inserts or tapped holes, as required. Engraved characters shall be block style with no characters smaller than 1/8-inch high.

B. Conductor and Equipment Identification: Conductor and equipment identification devices shall be either imprinted plastic-coated cloth marking devices, or shall be heat-shrink plastic tubing, imprinted split-sleeve markers cemented in place.

PART 3 - EXECUTION

3.1 GENERAL

A. Incidentals: The CONTRACTOR shall provide all materials and incidentals required for a complete and operable system, even if not required explicitly by the Specifications or the Drawings. Typical incidentals are terminal lugs not furnished with vendor supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor furnished equipment to connect with other equipment indicated in the Contract Documents

B. Field Control of Location and Arrangement: The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations shall be determined by the CONTRACTOR in the field based on the physical size and arrangement of equipment, finished elevations, and other obstructions. Locations shown on the Drawings, however, shall be followed as closely as possible.

1. Where conduit development drawings or "home runs" are shown, the CONTRACTOR shall route the conduits in accordance with the indicated installation requirements. Routings shall be exposed or encased as indicated. Conduits encased in a slab shall be sized for conduit OD to not exceed one-third of the slab thickness and be laid out and spaced to not impede concrete flow.
2. All conduit and equipment shall be installed in such a manner as to avoid all obstructions and to preserve head room and keep openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms as indicated. Where the Drawings do not indicate exact locations, such locations shall be determined by the ENGINEER. If equipment is installed without instruction and must be moved, it shall be moved without additional cost to the OWNER. Lighting fixture locations shall be adjusted slightly to avoid obstructions and to minimize shadows

C. Workmanship: All materials and equipment shall be installed in strict accordance with printed recommendations of the manufacturer. Installation shall be accomplished by workers skilled in the work. Installation shall be coordinated in the field with other trades to avoid interferences.

D. Protection of Equipment and Materials: The CONTRACTOR shall fully protect all materials and equipment against damage from any cause. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, or splashed with water, foam, plaster, or paint. All moving parts shall be kept clean and dry. The CONTRACTOR shall replace or refinish all damaged materials or equipment, including face plates of panels and switchboard sections, at no additional expense to the OWNER.

E. Incoming utility power equipment shall be provided in conformance with the utility's requirements.

F. The CONTRACTOR shall provide power to mechanical equipment in accordance with related section.

3.2 CORE DRILLING

A. The CONTRACTOR shall perform core drilling required for installation of raceways through concrete walls and floors. Locations of floor penetrations are approximate. Verify all exact core drilling locations based on equipment actually furnished as well as exact field placement. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities. Damage to any encased conduits, wiring, and piping shall be repaired at no extra cost to the OWNER.

3.3 CONCRETE HOUSEKEEPING PADS

A. Concrete housekeeping pads shall be provided for all indoor floor standing electrical equipment. Housekeeping pads for all equipment, including future units, shall be 100 mm above surrounding finished floor or grade and 50 mm larger in both dimensions than the equipment, unless otherwise indicated.

B. Concrete housekeeping curb shall be provided for all conduit stub-up in indoor locations that are not concealed by equipment enclosures. Such curb shall be 75 mm above finished floor or grade.

3.4 EQUIPMENT ANCHORING

A. Floor supported, wall, or ceiling pendant equipment and conductors shall be anchored in place by methods that will meet seismic requirements in the area where project is located. Wall-mounted panels that weight more than 220 kg or which are within 450 mm of the floor shall be provided with fabricated steel support pedestals. If the supported equipment is a panel or cabinet enclosed within removable side plates, it shall match supported equipment in physical appearance and dimensions.

B. Leveling channels anchored to the concrete pad shall be provided for all switchgear and pad-mounted transformer installations.

C. Anchoring methods and leveling criteria specified in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract. Such recommendations shall be submitted as shop drawings in Section 01300.

3.5 EQUIPMENT IDENTIFICATION

A. General: Equipment and devices shall be identified as follows:

1. Nameplates shall be provided for all panelboards, control and instrumentation panels, starters, switches, and pushbutton stations. In addition to name plates, control devices shall be equipped with standard collar-type legend plates.

2. Control devices within enclosures shall be identified as indicated. Identification shall be similar to the subparagraph above.

3. Toggle switches which control loads out of sight of switch and all multi-switch locations of more than 2 switches shall have suitable inscribed finish plates.

4. Empty conduits shall be tagged at both ends to indicate the destination at the far end. Where it is not possible to tag the conduit, destination shall be identified by marking an adjacent surface.

5. Equipment names and tag numbers, where indicated on the Drawings, shall be utilized on all nameplates.

6. The CONTRACTOR shall furnish typewritten circuit directories for panelboards; circuit directory shall accurately reflect the outlets connected to each circuit.

3.6 CLEANING

A. Before final acceptance, all parts of the WORK shall be thoroughly cleaned. Exposed parts shall be thoroughly clean of cement, plaster, and other materials. All oil and grease spots shall be removed with a non-flammable cleaning solvent. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Paint touch-up shall be applied to all scratches on panels and cabinets. Electrical cabinets or enclosures shall be vacuum-cleaned.

3.7 SITE TESTING, COMMISSIONING, CLIENT INSTRUCTION AND HANDOVER OF ENGINEERING SERVICES

A. GENERAL
The Contractor shall test, regulate, commission and set to work all installations and instruct the users representative in the correct methods of operations, regulation and maintenance procedures.

The Contractor shall supervise all testing etc., and provide labor, tools, scaffolding, test equipment, fuel, water, electricity and all other items needed to complete the installation including testing and commissioning.

B. NOTICE PRIOR TO TESTING
The Contractor shall give the Engineer seven day’s written notice of his intention to carry out a test and shall have carried out all necessary adjustment prior to commencing the test.

C. PROGRAMME
In conjunction with the building erection programmed all testing, regulating and commissioning procedures shall be detailed a systematic and progressive way such that all installations are completed, tested and commissioned and final documentation and demonstrations provided and all systems are operating satisfactorily before Practical Completion of the Contract is considered.

The programme for testing and commissioning shall be a separate document from other programme documents and shall include the following dates:-

- When the installations will be partially or totally complete.
- When each test will be carried out by the Contractor.
- When tests will be ready for demonstration/witnessing.
- When initial balancing/regulation will take place.
- When final balancing/regulation will be ready for witnessing.

The programme shall indicate test commencement and completion dates, the number of commissioning engineers engaged at each period and dated of events such as availability of water, power, heat and light.

The programme shall be prepared in conjunction with and agreed by all appropriate sub-contractors, suppliers etc. Six copies shall be issued to the Engineer.

The Programme shall be continuously reviewed and updated as necessary in order to reflect accurately the progress on site and six copies of each updated programme shall be issued to the Engineer.

D. SUBMITTALS

Four (4 No.) copies of all testing and commissioning documentation shall be submitted in bound covers indicated as follows:-

a. Certificates:

1. Equipment test certificates
2. System (s) test certificates

b. Data Sheets and Record Manuals:

1. Data sheets of test equipment to be used.
2. Full commissioning and testing data presented on approved record forms for all systems and equipment.

c. Drawings:

1. Equipment detail drawings.
2. Circuit diagrams for each system with design and actual flow rates and other pertinent data shown.

d. Record Forms:

3. Specimen copies of all commissioning record forms shall be submitted for approval of their use on this Project.

e. Programme of Work:

Fully detailed programme of work for inspecting, testing and commissioning the works, shall be submitted for approval.

E. INSTRUMENTS.

a. i) All necessary and required instruments for commissioning andtesting shall be included

ii) All instruments shall have been calibrated within a period of six months and carry a certificate of calibration to that effect. The instruments shall be selected to provide an accuracy compatible with the readings to be taken and the tolerances specified.

iii) The accuracy of the instruments shall be demonstrated to the Engineer and the use thereof shall be subject to his approval.

b. Test instruments shall be available for use to obtain the readings and recorded data required, and shall include but not be limited to the following:-

1. Temperature and humidities:

a. Electronic thermometers
b. Mercury in glass thermometers

2. Rotational Speed:

a. Direct read out electronic digital tachometer
b. Revolution counter and stop watch

3. Sound Levels:

a. Sound spectrum analyzer

4. Electrical:

a. Ammeters
b. Voltmeters
c. Multi-meters

5. Vibration:

a. Accelerometer

6. Recording Instruments:

a. Sound level recorder

F. TESTING:

The Contractor shall test all equipment, materials and installations as detailed in the appropriate documentation and specified elsewhere in this Specification. Records of checks and tests made at each stage shall be maintained.

G. COMMISSIONING:

When testing has been completed satisfactory commissioning procedures and setting to

work shall commence.

1. Setting to work
2. Balancing and Regulating to meet design parameters
3. Check that the values obtained compare satisfactory with the design values.
4. Make final adjustment before demonstrating that the systems operate correctly and that integration of each installation into the whole building installation has been achieved and that all systems operate efficiently and satisfactorily.

H. PERFORMANCE TESTS:

a. Carry out and supervise the operation of the commissioned installations for such a period as necessary to satisfactorily evaluate and demonstrate to the authorized representative, the performance of the installations by use of measuring and recording instruments that the installations function correctly and maintain the required conditions within the specified limits.

b. Provide artificial loads as required for the purpose of simulating internal and external loads.

c. During the trial period, plant & building conditions shall be checked & monitored, all necessary adjustments made & recorded on final report sheets.

d. During the trial period, provide training to the clients nominated staff in the operation of the plant.

e. No test or trial shall be carried out while conditions are abnormal.

f. Provide the Engineer with 14 days clear notice of proposed commencement date of performance tests.

I. TESTING IN SECTIONS:

The Contractor shall allow for testing and commissioning the installation in section as may be required in order to conform with the program.

J. TEST RESULTS:

The results of all test carried out shall be recorded and where appropriate the signature of the witnessing engineer. Test result sheets should indicate the date of the test, the name of the test engineer and witnessing officer and details of the test including:-

Type of test
System under test
Area or section being tested
Result obtained
Comments

Duplicate copies of all test result sheets shall be sent to the Engineer/ Employer representative within seven days of the test date and copies shall be included in the final handover documentation.

K. The Contractor to submit testing and commissioning procedures and forms prior to carrying out these activities

- END OF SECTION -

SECTION – 16065
Lightning Protection System

GENERAL

The contractor shall supply and install the lightening protection system with Faraday Cage Principal and as herein specified. The system shall include air terminal, main and secondary conductors, grounding, and all necessary parts to install a complete lightning system.

The system shall conform to the requirements of LIGHTNING PROTECTION CODE published by NEPA INSTALIATION CODE LPI-175 published by lighting Protection Institute, and the U/L Inc.

AIR TERMINAL

Air terminal shall be 1.0 meter-long, 98% conductivity copper and pointed rod taper, mounted as shown on the Drawings, and shall extend fixed to the parapet with approved clamps and support.

MAIN & SECONDARY CONDUTORS

Conductors shall be of 70 mm2 bare standard copper conductors and copper tape 25x3 mm.
Strand cross-section shall not be less than 2.5 mm2.
Conductors shall be run down to pits with minimum of bends. Bends shall be of large radius (minimum 20cm). Bends less than 20cm radius shall be supported at two points not more than 7.5cm on each side from the center line of the bend. Conductor shall run down as far as possible from any structural or other metal bodies. They shall be concealed architecturally as much as practicable so as not to affect the facades of the building

SPLICERS AND CONNECTORS

Splicers and connectors shall be cast metals

GROUNDING TERMINALS

Each down conductor shall terminate in at accessible grounding pit, Clamps connecting down conductors to ground rod for a distance of 4 measured parallel to the axis of the ground rod with the cable itself for a distance of at least 4cm. Clamps shall be secured with at least two bolts or cap screws. The resistance of the individual pits shall not exceed 50 ohms. The diameters of ground rod shall not be less than 1.5cm.

FASTENERS

Fastener shall be spaced not more than 1 m apart on all conductors. Nails, screws, or bolts employed to secure the Fasteners shall be of the same material as the Fasteners
Galvanized or plated steel nails or bolts are not acceptable mason anchors shall have a diameter of not less than 0.6 cm and shall be set with care holes to receive the shank of the fastener or fitting shall be of correct size made with proper tools and preferably made in the stones rather than in the mortar joints when set the fit shall be tight against moisture and capable of withstanding a pull test of 40 kg.

BONDING OF METALLIC BODIES

All metal parts of the building or requirement exposed to lightning strikes or within 60 cm of the lightning protection Fasteners shall be bounded to the grid by approved type of bolted connector .TV. antenna shall be bonded to the loop by a full-size copper cable a lightning arrester shall be installed on the lead in wire and bonded to the lighting protection system:

all connection of this nature shall be made with the use of splicers and fitting of an acceptable type.

All parts of the lightning protection system shall comply with BS standards, IEEE standards, or any other international standard.

The contractor shall submit one complete copy of system manuals and documentation.

The contractor shall guarantee the provided lightning system for two years. During guarantee period, the contractor shall be responsible for maintaining the system, replacing defected or damaged parts on his own account with no extra charges on the owner; also, the contractor shall remove the whole of the system and reinstall a new similar one if an unsolvable problem occurred in the system.

All calculations and shop drawings for the system shall be submitted by system agent through contractor for approval. All metallic parts on roof shall be connected to lightning system and drawings shall be submitted showing all details of connection and performance.

END OF SECTION

SECTION – 16070

EQUIPMENT CONNECTIONS AND SUPPORTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Types of Electrical Equipment Connections including, but not limited to, the following:

1 Connections for Socket outlets, isolators and other wiring devices.

2 Connections for Heating, Ventilation and Air-conditioning (HVAC) equipment.

3 Connections for Lighting fixtures and switches.

4 Connections for Master and secondary units of all low current systems including communication, signal, etc.

5 Connections for All equipment mentioned in other divisions of this Contract, which requires electrical power connections.

6 Connection for Grounding and bonding of all equipment.

B. Types of Supports for electrical and other installations including, but not limited to, the following:-

1. Equipment supports.
2. Conduits and raceways supports.
3. Anchors and fasteners.
4. Steel Welding.

1.02 RELATED SECTIONS

A.	Section 16050	Electrical Works, General
B.	Section 16075	Electrical Identification.
C.	Section 16120	LV Cables and Wires.
D.	Section 16130	Electrical Raceways.
E.	Section 16150	Wiring Devices.
F.	Section 16423	Enclosed Starters and Contactors.
G.	Section 16060	Grounding System.

1.03 REFERENCES

A. BS 7671 Requirements for Electrical Installations, (IEE 17th Wiring Regulations).

B. IEC

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan
4. Unless otherwise stated in the Contract method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
5. Technical performance of the equipment selected.
6. Dimensional details needed for installation and maintenance.
7. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of the complete range of all supporting devices and ancillary electrical connection materials including connectors, terminals, electrical insulating tape, electrical flux, cable ties, anchors, fasteners, equipment supports, etc., whose products have been in satisfactory use in similar services for not less than 5 years. Preference shall be given to local manufacturers and suppliers/agents.

B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.

1.06 delivery, storage and handling

A. Store products indoors with adequate protection against corrosion and damage.

PART 2 PRODUCTS

2.01 EQUIPMENT CONNECTIONS

A. Each equipment connection shall be provided with complete assembly of materials, including but not necessary limited to, pressure connectors, terminals, lugs, electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices and terminations of wires and cables.

B. Heavy gauge PVC and metal conduits, tubing and fittings of the required types, grades, sizes and thickness, for each type of electrical equipment connection shall be provided. Where types and grades are not indicated, provide proper selection to comply with wiring and raceway requirements. Provide products complying with section 16140 and in accordance with the following listing of conduit, tubing and fittings.

1. Heavy gauge PVC conduit and fittings (for indoor except plant rooms).
2. PVC coated rigid steel conduit and fittings (for outdoor, wet areas and plant rooms).
3. Rigid steel metal conduit and fittings.
4. Electrical metallic tubing and fittings.
5. PVC coated electrical metallic tubing and fittings.
6. Flexible metal conduit and fittings (for indoor except plant rooms and wet areas).
7. Liquid-tight flexible metal conduit and fittings (for outdoor, wet areas and plant rooms).

C. Electrical connectors, lugs and terminals for the wires and cables shall be provided as recommended by the connector and terminal manufacturer for intended applications.

D. Equipment connection accessories such as electrical insulating tape, heat-shrinkable insulating tubing and boots, solder, electrical soldering flux, wire nuts, cable ties, etc. shall be provided as recommended by accessories manufacturers for the intended applications and as approved by the Engineer.

E. For remote monitoring/controls of the electrical connections to various equipment, comply with the requirements.

2.02 EQUIPMENT SUPPORTS

A. All equipment supports including conduit and equipment supports, anchors and fasteners, etc. shall have adequate corrosion resistance against harsh and corrosive atmosphere.

B. All types of anchors, fasteners and supports shall be able to carry the loads of equipment and conduit. Weight of wires and cables in conduit shall be considered when selecting products.

C. Anchors and fasteners for various applications shall be used as detailed below:

1.	Concrete Structural Elements:	Use pre-cast insert system, expansion anchors and preset inserts.
2.	Steel Structural Elements:	Use beam clamps.
3.	Concrete Surfaces:	Use expansion anchors.
4.	Hollow Masonry, Plaster, and	Use toggle bolts and hollow wall fasteners.

	Gypsum Board Partitions:	
5.	Solid Masonry Walls:	Use expansion anchors and preset inserts.
6.	Sheet Metal:	Use sheet metal screws.
7.	Wooden Elements:	Use wood screws.

C. Any bolt utilized for equipment in the factory assembling or for site installation shall conform to BS, bolt, nuts and washers. All bolt shall be galvanized where any connection component is aluminum or galvanized steel.

2.03 STEEL WELDING

A. Except as specified otherwise, all welding and related material for welding shall be in conformity of IEC/BS standards and to the approval of the Engineer.

PART 3 EXECUTION

3.01 EQUIPMENT CONNECTIONS INSTALLATION

A. Install equipment connections in accordance with manufacturers' written instructions, recognized industry practices and the requirements of the applicable articles of BS to ensure that installations fulfill the intended applications.

B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible, mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

C. Co-ordinate installation of electrical connections for equipment with installation of other works.

D. Splices insulated by wound tape shall not be permitted. Protective grounding conductors shall be free of splices.

E. Prepare cables and wires by proper cutting/stripping of the armor covering, jacket and insulation to ensure uniform and neat appearance where cables and wires are terminated.

F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection testing and maintenance.

G. Tighten wire-binding connector screws firmly.

H. Provide PVC coated rigid steel conduit and fittings for wet areas, highly-corrosive atmosphere and outdoor installation. Provide liquid-tight flexible conduit for all motor connections and other electrical equipment connections when subject to one or more of the following:

1. Exterior location.
2. Wet areas with moist or humid atmosphere where condensate can be expected to accumulate (showers, baths, toilet, etc.).
3. Corrosive atmosphere.
4. Water spray.
5. Dripping oil, grease or water.

I. Provide heat shrinkable terminations for all LV cables having the size of 50 mm^2 and above.

J. Refer to the requirements of Section 16075, for electrical power supply connections of equipment and conductor terminations. Use appropriate wire markers and identification with respect to types, colors, letters and sizes, as approved by the Engineer. Affix markers to each point of termination as close as possible to the point of connection.

K. Where a conduit enters a box or other fitting, a bushing or grommet shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to afford equivalent protection.

3.02 Connections to fixed appliances

A. Final connections to various types of fixed domestic and industrial appliances shall be carried out by using either an armored copper cable or a flexible metallic conduit with heat resistant wires or sheathed cables.

B. Final connections made using flexible conduit shall comprise liquid tight flexible metal conduit covered with continuous PVC jacket and shall comply with the requirements given in Section 16140.

C. Sufficient length of the flexible conduit shall be allowed for any vibration and movement of the fixed appliances. A separate circuit protective conductor wire must be run inside the conduit.

D. A double pole or three pole isolator as required, adjacent to each fixed appliance shall be provided suitable for the power rating.

E. If final connection to the fixed appliances requires use of MICC cables, these shall comply with relevant standards and manufacturer's recommendations. MICC cable shall be formed into two loops before entering the fixed appliance, to allow for any vibration or movement.

3.03EQUIPMENT SUPPORTS INSTALLATION

A. All equipment supports including conduit and equipment supports, anchors and fasteners, etc. shall be installed in accordance with manufacturer's instructions, recognized industry practices and the requirements of the applicable articles of BS to ensure that the installation fulfil the intended applications.

B. Do not fasten supports to pipes, ducts, mechanical equipment and conduits.

C. Do not use spring steel clips and clamps.

D. Do not use power actuated anchors.

E. Do not drill or cut the structural members.

F. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

G. Install surface mounted cabinets and panelboards with minimum of four anchors.

H. In wet and damp locations use steel channel supports to stand the cabinets and panelboards at least 25 mm off the wall.

I. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

2.04 STEEL WELDING

A. The welders and welding procedures shall be qualified by an independent testing laboratory and subject to the Engineer's approval. Accurate records of the welders and procedure qualifications shall be submitted by the Contractor.

B. All welded joints exposed in exterior locations or subject to submergence in any location shall be provided with continuous welds along all the contact edges. Components to be welded shall be accurately positioned and shall be rigidly secured during welding.

C. All welds shall be properly identified on the detailed shop drawings and shall be subject to review by the Owner.

END OF SECTION

SECTION – 16075
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification to identify all electrical items for easy operation and maintenance including, but not limited to the following:

1. Nameplates and labels.
2. Wire markers.
3. Colour coding of raceways.
4. Circuit identification charts.
5. Cable identification tags.
6. Cable warning tapes.
7. Cable markers.
8. Equipment warning/danger signs.

1.02 RELATED SECTIONS

A.	Section 16150	Electrical Wiring, General.

1.03 REFERENCES

A.	IEC 364	Electrical Installations
B.	BS 7671	Electrical Wiring Regulation (IEE 17th)
C.	IEC 391	Marking of Insulated Conductors
D.	IEC 445	Equipment Terminals (Identification of Equipment Terminals and Terminations of Certain Designated Conductors).
E.	IEC 446	Identification of Bare Conductors by Colors or Numerals.

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

8. Name of the manufacturer.
9. Country of origin.

10. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.
11. Unless otherwise stated in the Contract method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
12. Technical performance of the equipment selected.
13. Dimensional details needed for installation and maintenance.
14. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product Testing Agency and include instructions for storage, handling, protection, examination, preparation and installation of the product.

1.05 QUALITY ASSURANCE

D. Manufacturers: Firms regularly engaged in manufacture of items the types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years. Preference shall be given to local manufacturers and agents/suppliers.

E. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.

F. All items of Electrical Identification shall be comply with the requirements of BS and Local Standards Organization.

PART 2 PRODUCTS

2.02 NAMEPLATES AND LABELS

A. Nameplates and labels shall be engraved on a three-layer 2 traffolyte plate having minimum thickness of 2 mm, securely screwed to the housing and have black letters on white background in Arabic and English.

B. The name plates and labels shall be required for each electrical distribution board, control panels, equipment enclosures, substation equipment, disconnect switches and equipment cabinets.

C. Lettering shall be block capitals standing :

1. 6 mm high for identifying individual equipment and loads.
2. 10 mm high for identifying grouped equipment and loads.

D. Labels using embossed adhesive tape with 6mm white letters on black background or transparent adhesive tape with 6 mm black letters, as selected by the Engineer, shall be used for identification of individual wall switches, receptacles, low current outlets, speakers, control device stations, junction/pull boxes, electrical boxes and fittings, etc.

2.03 WIRE MARKERS

A. Wire markers shall be split sleeve or tubing type.

B. The wire markers shall be required for each conductor at panelboard gutters, pull boxes, outlets, junction boxes and each load connection.

C. All power and lighting circuits, branch or feeder circuits and control circuits shall require wire markers.

2.04 COLOUR CODING OF RACEWAYS

A. Provide color bands with printed description of each system, minimum 75 mm wide for all cable trays/ladders and trunking runs. These color bands shall be applied at each electrical distribution/panel board, low current system control panels and junction box locations and at 15 m centers within an area.

B. Provide color bands with printed description of each system, minimum 25 mm wide for conduits up to 25 mm in diameter and one-half the conduit diameter for larger conduits, applied at panel and pull box locations, within each room, and at 6 m centers within an area.

C. Following color banding shall be used for the raceways of various electrical systems, however subject to final decision of the Engineer. Color bands for the electrical systems not described here shall be as agreed on site:

1. Lighting: gray.
2. Normal Power: brown.
3. Essential Power : black
4. Earthing : green.
5. Fire alarm : red.
6. Sound : yellow.
7. Data : purple.

2.05 CIRCUIT IDENTIFICATION CHARTS

A. Individual circuit identification charts shall be provided for all panelboards, distribution boards, control panels, etc. giving following information as a minimum.

1. Circuit numbers
2. Phase
3. Load names with location.
4. Connected load.
5. Outgoing terminal numbers.
6. Sizes and types of protective devices.
7. Sizes and types of incoming and outgoing cables.
8. Contacts location references of relays and other control devices (if any).

B. Charts shall be typed on A4 size sheets. They shall be enclosed in a clear plastic envelope and shall be securely fixed to the inside cover of the unit. Additional copies of the charts shall be included in the Operation and Maintenance Manuals.

2.06 CABLE IDENTIFICATION TAGS

A. All cables which exit from manholes, vaults and handholes or switch enclosures shall be properly tagged or labeled. Tags shall be permanent, non-corrodible and clearly readable. Tags should include the information listed below for the various circuit categories:

Primary Cables
Feeder Name
Voltage
Phase (for single conductor cables)

B. Cable identification tags for wire and cable circuits shall be of an opaque nylon material arranged to include a marker plate, non-releasing nylon ties, and cable fastening tail. One side shall be roughened to hold black nylon permanent ink. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device, and prevent removal of the tail without cutting it loose from the marker. Cable identification shall be inscribed in Arabic and English.

2.07 CABLE WARNING TAPES

A. For buried LV and HV cables use warning tapes according to the standard practice of Electricity Supply Authority and applicable international standards.

B. Cable warning tapes shall be of polythene, not less than 150 mm wide and at least 0.25 mm thick. They shall be yellow in color for LV cables and bear the continuously repeated legend – "CAUTION ELECTRIC CABLE BELOW" or similar in English and Arabic, in black letters not less than 30 mm high.

C. For buried low current/communication cables or duct banks, use warning tapes as per the standard practice of Local Telecom Supplier and applicable international standards.

2.08 CABLE MARKERS

A. Except where cables are buried, located in switch rooms, in ducts and spaces designated solely for electrical services, or have orange over sheaths; they shall be identified by adhesive bands colored orange, complying with standards and codes of practice mentioned elsewhere in the Specifications. The bands shall be not less than 100 mm long, located at least once within each separate compartment through which cables pass and at intervals not exceeding 12 m.

B. Except where cables are buried or enclosed in conduit, trunking or ducting; they shall be permanently identified by discs. The discs shall be of laminated plastic materials with black character on white; character shall be not less than 3 mm high. The inscription shall indicate the nominal voltage, the designation of the load, the number and cross sectional area of cores and the rated voltage of the cable.

C. Cables identification discs shall be attached to the cables with ties. Disc shall be located within 500 mm of terminations and joints, at least once within each separate compartment through which the cable passes, and at intervals not exceeding 24 m, they shall coincide with the colour bands.

2.09 EQUIPMENT WARNING/DANGER SIGNS

A. For external use, pressure sensitive danger signs shall be used. Dimensions shall be as approved by the Engineer. The signs shall be heavy duty vinyl with a self- adhesive backing which can be applied to curved or irregular surfaces. Danger signs shall be weather-resistant and shall not discolor or deteriorate with age.

B. Danger signs shall be inscribed with the equipment voltage level along with an internationally recognized danger sign.

C. Warning/Danger signs made of red plastic (vinyl) with white letters at least 15 mm high reading "DANGER 400V"or "DANGER 230V" as appropriate, shall be fixed to the lids, covers or doors of any equipment which contains terminals or conductors connected to more than one phase of a low voltage supply.

D. All signs shall be in English and Arabic.

2.10 LANGUAGE A. The English & Arabic languages shall be used for all labeling and charts.

PART 3 EXECUTION

3.01 PREPARATION

A. De-grease and clean surfaces to receive nameplates and labels.

3.02INSTALLATION

B. Install warning and descriptive labels as follows :

1. Metallic surfaces using stainless steel or chromium plated bolts and/or self tapping screws.
2. Concrete surfaces or masonry walls using and brass wood screws.
3. Timber surfaces using minimum 6 mm countersunk brass screws.
4. All insulated enclosures using an approved plastic welding adhesive.

A. The danger sign and identification number shall be affixed to the front or access doors of all transformers and switches. For equipment with two doors the danger sign shall be mounted on the left door with the identification number mounted on the right door. Both the danger sign and the identification number shall be centered 300 mm below the top edge of the doors and on the vertical centerline of each door.

B. On equipment with only one access door, the danger sign and the identification number shall be centered on the vertical centerline of the door, with the horizontal centreline of the danger sign 300 mm below the top edge of the door and the horizontal centreline of the identification number 250 mm below the danger sign centerline.

C. Locate cable markers at every point where cable(s) enter a building, sub-station, distribution/feeder pillar; at each joint, change of direction, road/pathway crossing, etc. Cable markers shall also be provided along the straight runs (route) of the cable(s) at the interval not exceeding 30 m.

END OF SECTION

SECTION – 16120
LV CABLES AND WIRES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Multicore and single core LV Cables and Wires including, but not limited to, the following:

1. Single core/building wires.
2. Multi-core flexible cables.
3. XLPE/PVC insulated cables.
4. Heat/fire resistant cables.
5. Splices and terminations.
6. Cable markers, supports and ties.

1.02 RELATED SECTIONS

A.	Section 16050	Electrical Works General.
B.	Section 16075	Electrical Identification.
C.	Section 16070	Equipment Connections and Supports.
D.	Section 16910	Electrical Testing & Commissioning.

1.03 REFERENCES

A.	BS	British Standard
B.	IEC 228	Conductors for Insulated Cables.
C.	IEC 502	Extruded Solid Dielectric Insulated Cables for Rated Voltages from 1 kV up to 30 kV.
D.	BS 6004	Specification for PVC Insulated Cables (non-armoured) for Electric Power and Lighting.
E.	BS 6121	Mechanical Cable Glands (Specifications for).
F.	BS 6500	Specification for Insulated Flexible Cords and Cables.
G.	BS 6746	Specification for PVC Insulation and Sheath of Electric Cables.
H.	BS 7671	Requirements for Electrical Installations (IEE Wiring Regulations, 17th Edition).

1.04 SUBMITTALS

A. Submit samples of each type of cable proposed.

B. For all types and sizes of LV Cables and Wires, submit the following Manufacturer's details:

1. Dimensions.
2. Weight.
3. Construction.
4. Current rating.
5. Manner of installation.
6. Maximum conductor operating temperature.
7. Volt drop/amp/meter.
8. Impedance: Separate resistance and reactance values of single and multicore cables.
9. Resistance of armouring in ohms/1000 m length of cable.
10. Characteristic curves for short circuit rating.
11. Minimum bending radius.

C. Submit factory/shop test results showing test voltages, duration of tests and other details for each routine test, in accordance with the requirements of IEC and BS standards. Manufacturer shall submit the results of type tests, if required by the Engineer.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of LV cables and wires of the types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and agents / suppliers.

B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.

C. Cables and wires shall generally be Manufacturer's standard construction and materials. Where this contradicts any part of the Specifications, the Contractor shall state so, at the time of tender.

D. All LV cables, wires and accessories furnished under these Specifications shall conform to the applicable standards of Local Standards Organization, IEE, IEC and BS.

1.06 DELIVERY, STORAGE AND HANDLING

A. End of cables shall be sealed to prevent ingress of moisture.

B. Where cables are transported on drums, these shall have adequate circumferences for the cables. Drums shall not be transported on their sides. Each cable drum shall be provided with appropriate weatherproof metallic label indicating project name, order no., type, size and length of the cable delivered. The reels for small building wires shall be provided with appropriate tags indicating at least the type, size and length of wire delivered.

C. After winding on drums, cables shall be protected by being completely enclosed.

D. Care shall be taken during transit to avoid damage to cable and drums. Before acceptance on site, cable drums and cables shall be inspected for:

1. Damage.
2. Compliance with Specifications.
3. Quantity.

E. Store all LV cables, wires and accessories in factory installed coverings in a clean, dry indoor space which provides protection against the weather and direct exposure to the sun light.

F. As far as possible, each distribution cable shall be supplied in one continuous length without any joint. Where the required run length of any individual cable exceeds the standard/maximum length of a cable drum, as manufactured in the factory, the cables shall be jointed with prior approval of the Engineer using an approved cable joint.

G. Cables shall be handled with care and every effort made to avoid damage to the cable, to other services and to building fabric. Recommendations or instructions available from the cable Manufacturers concerning the installation of cables shall be taken into account. Any damage shall be reported immediately to the Engineer.

H. Cable drums shall be unloaded carefully by means of either a crane or ramp and impact with the ground shall be avoided. They shall be supported on axles and axle stands while the cable is being pulled; twisting and abrasion of the cable serving or oversheath shall be avoided.

1.07 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 PRODUCTS

2.01 SINGLE CORE /BUILDING WIRES

A The conductors of all single core wires shall be of high conductivity, plain, circular, stranded, annealed copper conductors as per IEC 228.

B. The insulation of single core wires shall be heat resistive PVC type 5 to BS 6746, rated at 85 ^{o}C for continuous operation. Manufacturer shall guarantee that insulation will not emit any toxic fumes in the event of a fire.

C. The building wires shall comply with BS 6004 Table 5, rated 600/1000V grade for power cables and 450/750V grade for lighting & Power fixtures & receptacles.

D. Wires shall be coloured in accordance with section 514 of the IEE Wiring Regulations 17thEdition (BS 7671).

2.02 MULTI-CORE FLEXIBLE CABLES

A. Multi-core flexible cables shall be used for the connections of pendant lighting fittings, final equipment connections, portable equipment or any other purpose as shown on the Drawings or approved by the Engineer.

B. The flexible cables shall be of circular construction, rated 300/500 V grade and comply with BS6500 Table 12.

C. The flexible cables shall be of high conductivity, circular, stranded, annealed copper conductors, insulated with heat resistive PVC type 4 to BS 6746, rated at 85 ^{o}C for continuous operation.

D. The overall sheath of the multi-core flexible cables shall be of heat resistive PVC type 4 to BS6746 or polyethylene as approved, rated at 85 ^{o}C for continuous operation.

E. Manufacturer shall guarantee that the insulation and overall sheath of the cable will not emit any toxic fumes in the event of a fire.

F. The cores of multi-core flexible cables shall be coloured in accordance with Section 514 of the IEE Wiring Regulations, 17th Edition (BS 7671).

2.03 CROSS-LINKED POLYETHYLENE (XLPE) INSULATED CABLES

A. All low voltage distribution cables shall be copper conductors, 600/1000V grade, cross-linked polyethylene (XLPE) insulated and PVC or polyethylene sheathed cables complying with IEC 502.
B. Provide LV distribution cables single-core or multi-core and unarmoured or armoured.
C. Cable conductors shall be of high conductivity plain, circular or sector shaped, stranded copper as per IEC 228 and insulated with cross-linked polyethylene (XLPE) rated at 90 ^{o}C for continuous operation.
D. The assembly of multi-core armoured cables shall be filled with non-hygroscopic material, compatible with the insulation and covered with a layer of PVC bedding, which may be an integral part of the filling.
E. Where shown on the Drawings, armoured single-core LV cables shall have non-magnetic armour wire. Single-core cables armoured with steel wire or tape shall not be used for a.c. circuits to prevent eddy (induced) currents. Such conductors shall neither run individually in a ferrous enclosure or pipe nor shall be surrounded by any ferrous material.
F. The armoured multi-core cables shall consist of a single layer of galvanised steel wires applied over the PVC bedding.
G. Both armoured and un-armoured multi-core LV cables shall be sheathed overall with PVC type ST2 to IEC 502 or polyethylene as approved.
H. Manufacturer shall warranty that the insulation and overall sheath of the cable will not emit any toxic fumes in the event of a fire.
I. Steel wire armouring of the multi-core armoured cables shall be securely bonded to earth at each termination by means of an adequately sized metallic bond which shall be as short and straight as it is practicable.
J. Cable cores shall be coloured in accordance with section 514 of the IEE Wiring Regulations, 17th Edition (BS 7671).
K. Joints shall not be allowed in any cable, unless a prior written approval of the Engineer is obtained.

2.04 LOW CURRENT CABLES

A. Provide cables for all low current systems according to the requirements given in the relevant section of each system contained elsewhere in these Specifications. All such cables shall comply with the applicable international standards.

2.05 SPLICES AND TERMINATIONS

A. Cable splicing or jointing shall not be allowed in any circumstances, except where the required run length of any individual cable exceeds the maximum/standard length as Manufactured in the factory. Obtain Engineer's written approval for any splice or joint, prior to ordering the cable.

B. Splices and terminations for all LV. cables rated 600/1000 V grade shall be furnished in kit form and shall conform to the recommendations of the cable manufacturer. All material shall be furnished in factory sealed packages and shall not be opened until required for use.

C. Splices for all LV cables shall be pre-molded or heat shrink type and rated for continuous duty at the rating of the services to which they are connected. They shall be suitable for direct buried underground installation or mounted on cable trays as per the requirements on site.

D. Terminations shall be insulated using the materials specified and the procedures recommended by the Manufacturer of the kit being used.

E. Splices for the earth shall be made exothermally or as per the recommendations of the LV cable splice Manufacturer.

2.06 CABLE MARKERS, SUPPORTS AND TIES

A. Cable markers and identifications discs for all LV cables shall be provided in accordance with the requirements given in Section 16030.

B. Cleats, saddles and clips used for fixing cables shall be black nylon for up to 20 mm dia. cables and glass reinforced nylon for cables above 20 mm dia. All saddles and clips shall be secured using brass round screws for cables up to 20 mm dia. and 10 mm hexagon headed zinc plated bolts and studs above 20 mm dia.

C. All LV cables shall be tied on cable trays/ladders by non-releasing type nylon ties or approved clamps.

D. Clamps for single core cables shall be of non-ferrous material.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions under which the cables are to be installed and correct any unsatisfactory conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until all unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02 SUB-CIRCUIT WIRING INSTALLATION

A. The sub-circuit and final circuit wiring for lighting, small power and equipment power installations shall take the following forms:

1. Single core stranded PVC insulated wires in trunking or conduits for internal wiring.
2. Multi-core XLPE/PVC insulated unarmored cables in cable trays, ladders or conduits for

internal wiring.

3. Multi-core XLPE/SWA/PVC insulated armored cables in conduits, cable trays, ladders duct banks or direct buried for external wiring.

B. The types of lighting and small/equipment power installations and accessories are detailed elsewhere in the Specifications and on the Drawings.

C. No conductor smaller than 2.5 mm2 shall be used. Minimum size of direct buried cables whether used for external lighting or any other purpose shall be 4.0 mm^2.

D. Each lighting circuit shall be wired using the "loop-in" continuous wiring system and as shown on the Drawings.

E. Small power installations shall be wired using the radial system or ring for special applications as described on the Drawings.

F. Equipment power installations shall generally be wired on a single circuit basis (1-phase or 3-phase), as shown on the Drawings and will serve fixed items of equipment.

G. Each lighting and small/equipment power circuit shall have a separate circuit protective conductor throughout to each light/switch point, power socket outlet or fixed equipment.

H. Where a lighting or small/equipment power circuit is to be installed in trunking or conduit together with any other circuit(s) deviating from drawings, the circuit conductor shall be de-rated for grouping in accordance with table 4B1 of the IEE Wiring Regulations, 17th Edition. This will normally result in the need to increase the conductor sizes as shown in the Panelboard Schedules or on the Drawings.

I. Not more than 2 final sub-circuits shall be run in any conduit.

J. Normal and emergency circuit wiring/cables for lighting, small/equipment power or any other purpose shall be run in separate conduits or in separate compartments of trunking or on separate cable trays/ladders in accordance with IEE Wiring Regulations, 17th Edition.

3.03 INTERNAL CABLE INSTALLATION

A. Where cables enclosed in conduits and run vertically in excess of 5 m, the cables shall be clamped to relieve strain on the cables, using suitable approved clamps.

B. Where multiple circuit wiring follows a common route then the wiring shall be installed in trunking rather than multiple conduits with prior approval of the Engineer.

C. Where cables and wires run in trunking, each circuit or group of circuits shall be clipped together using nylon straps or other suitable straps or clips. Vertical runs of trunking exceeding 5 m shall be supplied with pin racks to relieve the strain on cables.

D. All cable runs shall be continuous, no joints will be permitted except where the required run length of an individual cable exceeds the standard/maximum length of a cable drum as manufactured in the factory. Obtain approval of the Engineer for each joint, prior to ordering the cables.

E. Extreme care shall be exercised to prevent tension during bending of LV cables. The permanent radius of cables bend at any location after installation shall not be smaller than the cable Manufacturer's recommendations.

F. Where cables are supported on cable tray, they shall be fixed to the cable tray using suitable

approved straps or clips. Ties shall be spaced at not greater than 600 mm intervals along each cable, and within 100 mm of each bend or set.

G. Where cables are laid on cable trays or ladder in mechanical or electrical rooms or prone to be damaged elsewhere on the project, they shall be mechanically protected by a cover to a height not less than 2 m from the finished floor level.

H. When installing cables, care shall be taken to ensure that electrolytic action does not take place between dis-similar metals used for cable trays, ladders, supports, clamps, etc.

I. Each cable gland shall be from the same Manufacturer as the cable on which it is used and shall be stamped describing the size and number of conductors. PVC shrouds shall be used to protect every gland.

J. Power and lighting cables can be installed on a single cable tray or cable ladder. However normal and emergency power cables shall be installed either on separate cable trays/ladders or separated by mechanical separators if combined on a single cable tray/ladder.

K. TV, Communications and other low current cables shall be installed on separate cable trays with fire alarm cables separated by mechanical separators from other cables.

3.04 EXTERNAL CABLE INSTALLATION

A. No work shall commence until the Contractor has investigated the site satisfactorily, and ascertained that the area is free from drains or other underground services. The Contractor shall obtain approval of the routes for external cable with appropriate installation details on shop drawings prior to commencement of any excavation on site.

B. Unless otherwise indicated, excavations within 600 mm of existing services shall be by hand digging. All services uncovered, whether expected or not, shall be reported immediately to the Engineer; they shall be supported by slings or other suitable means and protected. Any damage to services, however minor, shall be reported immediately to the Engineer; no repairs or replacement shall be done unless the Engineer gives his approval.

C. When cable trenches are opened, all cables shall be laid as quickly as possible. The Engineer's approval shall be obtained before a trench is backfill, generally backfilling shall be commenced within 24 hours of cable laying and the work completed speedily.

D. Keep excavations shall free of water and protected against damage or collapse. The safety of persons and the protection of structures, buildings, roads and services from damage shall be ensured.

E. Before cables are laid, grade bottom of the trench evenly, clean out loose stones and cover for the full width of the trench with a 150 mm layer of sieved sand. Where the level of the trench bottom varies the slope shall not be greater than 1 in 12.

F. Pull cables over cable rollers adequately spaced to prevent the cable being dragged over ground or other surfaces. For cables pulled into thrust boring or cables ducts and for all cables exceeding 10 m length, use cable stockings for hauling. Precautions shall be taken to ensure that strain is taken on the cable cores as well as the sheath and excessive strain shall be avoided.

G. After cables have been laid, a further layer of sieved sand shall be added over the full width of the trench and tamped to provide finally not less than 150 mm cover over the cables.

H. Backfill trenches in layers and compact layer before the next layer. The first two layers shall be 100 mm deep and compacted by hand; then mechanical compacting may be used. Cable warning tapes only shall be provided over the external lighting cables, but warning tapes and cable

protective tiles shall be used over LV power cables.

I. Warning tapes shall be of polythene not less than 150 mm wide and at least 0.25 mm thick. They shall be yellow in color and bear the continuously repeated legend "-CAUTION ELECTRIC CABLE BELOW" - or similar in English and Arabic, in black letters not less than 30 mm high.

J. Provide cable protective tiles in accordance with the applicable regulations and standards. Cable protective tiles shall be placed directly on the compacted sand cover over the cables.

K. Where cables laid in trenches and cross other cables; a minimum clearance of 250 mm between the crossing cables shall be maintained. Cables shall not be laid one above the other except where shown on the Drawings.

L. If more than one cable is to be drawn in a duct, all such cables shall be bunched together and pulled in one operation, wherever possible.

M. Where cables run under roadways, install in PVC ducts encased in concrete. The ducts shall extend for a minimum distance of 1 m on each side of roadway and shall be sealed at each end.

N. Ducts shall be sized to allow installation of cable without excessive tension loads. 20% spare ducts shall be provided with a minimum of one spare duct at each location.

O. When installed in cable ducts, all multi-core cables shall be installed singly and continuous between the manholes. Splicing of cables between the manholes shall not be allowed in any case.

P. For cables pulled into thrust borings or cable ducts exceeding 10 m length, use cable stockings for hauling. Precautions shall be taken to ensure that strain is taken on the cable cores as well as on the sheath. The pulling tension of the cable shall not exceed the maximum tension recommended by the cable Manufacturer.

Q. Utilize both manual and power type pulling mechanisms on site as required with the rated capacity (in kilograms or pounds) clearly marked on the mechanism. A dynamometer shall be used to show the tension on the cable during all pulls and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected. The dynamometer shall have a maximum tension indicator to show the maximum tension developed during a pull. The cable play-out reel shall be equipped with a suitable brake and shall be constantly manned during all pulls.

R. Under no circumstances shall cable be pulled using equipment not monitored by a dynamometer. The use of motor vehicles in pulling cable is prohibited. Any cable so pulled shall be removed and replaced.

S. To avoid insulation damage from excessive sidewall pressure at bends in raceway runs, the pulling tension in the cable in kilograms as it leaves the bend shall not exceed 500 times the radius of the bend in meters.

T. Support cables at all times without excessive sag. Cables shall be located in such a way as to minimize interference with other cables to be installed.

U. Provide adequate length of cables in manholes to avoid distorting pressures on the cables at conduit bushings. Cable protection such as a layer of light rubber belting, friction tape or similar material shall be provided where required before permanently fixing the cables in place.

V. Install and support cables in such a way that there shall be no undue mechanical strain on the cable terminations. The requirements of the IEE Wiring Regulations, 17th Edition, chapter 52 shall be fulfilled for the erection of LV cables, as applicable.

W. Terminate cables using only the correct size and type of gland with earth tag and PVC shroud, as supplied or recommended by the cable Manufacturer. All glands shall be dustproof and the glands for outdoor usage shall be fully weather and waterproof.

X. Bend cable armoring to earth at each termination by means of a green/yellow Cu/PVC earth conductor, sized in accordance with Section 543 of the IEE Wiring Regulations, 17th Edition, connecting the cable gland earth tag to the local earth terminal. The apparatus gland plate shall be cleaned to bare metal around the cable gland earth tag bolted connection to ensure a sound electrical connection.

Y. Where cables pass through walls or floors, protect by PVC or mild steel sealed sleeves cast into the building fabric. If the walls or floors are fire divisions, then the sleeves shall be fire stopped after installation of the cable(s) to the same rating as the walls or floors through which they pass.

Z. Where cables pass through ducts or sleeves entering buildings, seal the ends of the ducts or sleeves using a special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 ^{o}C, and shall not slump up to a temperature of 149 ^{o}C or less. It shall not be hardened materially when exposed to air.

AA. Install cable markers and identification discs in accordance with the requirements given in Section 16075 and locate them so that they are readily visible when cable is permanently fixed in position.

3.05 SPLICING AND TERMINATIONS

A. Cable splicing or jointing is not allowed, except where the required run length of any individual cable exceeds the maximum/standard length as manufactured in the factory. The Contractor shall obtain Engineer's written approval for any splice or joint, prior to ordering the cable.

B. The Engineer shall be informed whenever cables are to be spliced or terminated.

C. The Engineer shall be given evidence that the joint or termination Manufacturer has stated that materials to be employed are suitable for the type of cable to be jointed or terminated.

D. Supply and install all materials, equipment and accessories necessary for the proper jointing, terminating and connecting, ready for service, of all cables included in the works.

E. Employ for this work, staff who are fully qualified and competent for the types of joints and terminations to be made.

F. Take all necessary precautions to prevent damage and ingress of moisture and impurities; cables ends shall be made free from moisture before jointing commences. Where circumstances prevent completion of the jointing or termination, the cable ends shall be sealed properly.

G. All jointing and terminations, once commenced, shall proceed continuously until it is completed and sealed in the shortest possible time, without interruption. No terminations shall be made under wet or dirty conditions.

H. Terminate all cables in brass compression glands complying with BS 6121 and of a design appropriate to the type and size of cable(s) being terminated. Glands for armoured cables shall be provided with a properly designed clamping device for the armour or screen. All cable glands shall be provided with a dust and waterproof outer sheath seal.

I. Provide compression glands with earthing tags and close-fitting PVC shrouds.

J. Except where it is impracticable to do so, the cable cores shall be taken through the terminating

box directly to the terminals of the equipment, without crosses, and shall be made off with an approved type of hydraulically crimped socket.

K. The cores of all cables shall be correctly 'phased out' before the final jointing, terminations or connections are made. Continuity of spare cores shall be maintained at joints. At terminations, any spare cores shall be connected to spare terminals.

L. At all cable terminations the armoring or metallic sheath of the cables, if any, shall be solidly bonded to the equipment earth terminal or bar by means of properly designed brass or copper clamps and a copper conductor of section not less than that required by the IEE Wiring Regulations, subject to a minimum section of 2.5 mm^2.

M. Core identification at terminations shall be done by colored or numbered plastic stretch or shrink ferrules.

N. Utilize appropriate crimping tools for splicing and termination of all cables with guides to position the connectors or lugs in the tool correctly. The connectors, lugs and associated dies for the compression tool shall be of correct type and size. The crimping tool shall be designed with steps to prevent over crimping and shall be of a type which have provision to prevent the tool from opening until the crimp action is completed.

O. Tools for manipulation and termination of cables shall be of a design approved by the cable Manufacturer. Corrugation of the metal sheath or damage to outer coverings will not be accepted. A wood block or wooden faced tool shall be used to finally dress the cable into position.

P. Repairs to a cable sheath, regardless of the extent of the damage, will not be accepted; straight through joints only are permitted.

Q. Splices shall not be made to utilize short lengths of cable. When cables being installed into a duct system with manholes, the splices shall only be provided within manholes and no splice shall be allowed outside the manholes.

R. Jointing and terminations shall be made in accordance with the Manufacturer's instructions.

S. The sleeves used for jointing and terminations shall be shrink type, applied cold or by the use of heat. They shall provide a sufficient thickness of insulation to suit the particular application.

T. The insulation tapes used for jointing and terminations shall have temperature rating and insulating property not less than the cable insulation. They shall be fully compatible with the type pand size of cables and comply with the applicable standards and regulations.

3.06 FIELD QUALITY CONTROL

A. Comply with Section 16910.

B. All LV cables and wires shall be tested when splicing and terminations are fully prepared and completed, except for final connections of cables/wires tails onto equipment.

C. Test each conductor for phasing, continuity and insulation resistance (meggar).

D. After completion of the installation of L.V. cables and wires, carry out insulation resistance test for 1 minute at 500 V or 1000 V, according to the rated voltage of the cables/wires under test. The test voltage shall be applied between the conductors and between each conductor and earth/neutral and shall comply with the requirements of IEE Wiring Regulations, 17th edition and other applicable standards.

END OF SECTION

SECTION – 16128
RACEWAY FIRST FIX

PART 1 GENERAL

1.01 section includes

A. Electrical Raceways, accessories and Boxes / Fittings including, but not limited to, the following:

1. PVC Conduits.
2. Rigid Steel Conduits.
3. Flexible Conduits.
4. Interior outlet boxes.
5. Weatherproof outlet boxes.
6. Junction/pull boxes and cabinets.
7. Floor boxes.
8. Conduit bodies.
9. Fittings.

1.02 related sections

A. Section 16075 Identification For Electrical Systems.

B. Section 16120 LV Electrical Power Conductors and Cables.

C. Section 16070 Equipment Connections and Supports.

D. Section 16134 Underground Electrical Services.

E. Section 16150 Wiring Devices and Disconnecting Switches.

F. Section 16070 Equipment Wiring Connections.

G. Section 16130 Conduits and backboxes for Electronic Safety and Security.

1.03 REFERENCES

A. The IEE Wiring Regulations, 17th Edition (2008).

B. BS 4568Rigid Steel Conduits, Zinc Coated.
C. BS 6099-2.2 / IEC 614-2-2 U.P.V.C. Rigid Conduits.

1.03 SUBMITTALs

C. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.

D. Product Data: Submit for the following:

1. Flexible metal conduit.
2. Liquid tight flexible metal conduit.
3. Nonmetallic conduit.
4. Flexible nonmetallic conduit.
5. Nonmetallic tubing.
6. Raceway fittings.
7. Conduit bodies.
8. Surface raceway.
9. Wire way.
10. Pull and junction boxes.
11. Handholds.

E. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.04 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of raceways of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and agents/suppliers.

B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.

C. ELECTRICAL RACEWAYS SHALL GENERALLY BE MANUFACTURER'S STANDARD CONSTRUCTION AND MATERIALS. WHERE THIS CONTRADICTS ANY PART OF THE SPECIFICATIONS, THE CONTRACTOR SHALL STATE SO AT THE TIME OF TENDER.

1.05 DELIVERY, STORAGE AND HANDLING

A. Product Requirements for storage and handling.
B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
C. Protect PVC conduit from sunlight

1.06 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 PRODUCTS

2.01 PVC CONDUITS

A. All PVC conduits and fittings shall be UPVC heavy gauge, rigid, direct buried or encased buried type as applicable, complying with BS 6099-2.2 / IEC 614-2-2 heavy gauge in all respects, and may be used where ambient temperatures do not exceed 75° C.

B. All PVC conduits and accessories shall be obtained from the same manufacturer.

C. No conduit shall be less than 20 mm diameter.

D. Fittings and accessories for PVC conduits shall include, but not be limited to, the adapters, junction/pull boxes, bushings, couplings, elbows, nipples, plugs, seals, etc.

E. Conduit boxes shall be of the circular pattern with appropriate spout entries and 50.8 mm accessory fixing centers.

F. All connections and terminations of the PVC conduits and fittings shall be by means of the manufacturer's standard adaptor.

G. All boxes shall have brass thread inserts for the fixing of accessories or covers.

H. All tees shall be made using conduit tee boxes. Tangential entry boxes shall be used where appropriate. Multiple conduits may necessitate the use of large UPVC adaptable boxes for junctions.

I. All saddles shall be of the spacer bar type and from the same manufacturer as that of the conduit which they are being used to secure.

J. All wall mounted accessory boxes shall have one adjustable fixing lug to facilitate final leveling of accessories.

2.02 RIGID STEEL CONDUITS (rsc)

A. All Rigid Steel Conduits (RSC) and accessories shall be heavy gauge welded steel complying with BS 4568, not less than 20 mm diameter.

B. RSC and fittings shall be hot dipped galvanized, complying with BS 4568, and providing heavy protection both inside and outside. The steel shall be galvanized after cutting and threading.

C. All conduits and fittings shall be threaded, free from rust or other defects and shall have same hot dipped galvanized finish throughout the installation.

D. Fittings and accessories for RSC shall include, but not be limited to, adapters, junction/pull boxes,

bushings, connectors, couplings, elbows, expansion joints, gaskets, hubs, locknuts, nipples, plugs, seals, breathers, etc.

E. Fittings and accessories for RSC shall be of malleable iron or a mixture of grey iron and cast steel.

F. All bushes shall be hexagonal headed, heavy duty, long threaded brass bushes complete with serrated tempered shake proof washers. All bends shall be cold set. All tees shall be made using circular tee conduit boxes.

G. All saddles for surface mounted installation of RSC shall be of the spacer bar type and of the same finish as that of the conduit which they are being used to secure.

H. A tapped earth connection facility shall be provided in every box.

I. All accessory boxes shall have one adjustable fixing lug to facilitate final leveling of accessory.

J. PVC coated RSC and fittings shall be used for cables extending to outside of building and where above grade extensions of PVC Conduits required a transition from PVC to RSC.

2.03 FLEXIBLE CONDUITS

A. Flexible conduits shall be liquid-tight, constructed from galvanized steel core and continuous liquid-tight PVC jacket in accordance with BS 731 Part 1, not less than 20 mm diameter.

B. Flexible conduit shall only to be used for final connection to items of fixed equipment subject to vibration or movement.

C. All flexible conduits shall have a liquid-tight PVC jacket capable of withstanding 90 ^{o}C cable operating temperatures.

D. All fittings and accessories for liquid-tight flexible steel conduits shall be nylon jacketed.

E. Nylon jacketed brass adaptors shall be provided for connection at either end of the flexible conduit and should be of the compression type.

2.04 INTERIOR OUTLET BOXES

A. All interior outlet boxes shall be constructed in compliance with BS 4662 type UA1.

B. Outlet boxes shall be with 1.1mm thickness and 7x7 cm or 7x14 cm size and 3.8 & 4.7 cm depthS with adjustable lug.

C. Provide galvanized flat, rolled sheet steel interior outlets and switches wiring boxes of types, shapes, sizes and depths to suit each respective location and installation. Construct threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.

D. Brass earthing terminal with screw shall be provided inside the box for grounding connection of all metallic outlet boxes with appropriate earth mark.

E. Accessories for interior outlet boxes such as mounted brackets, wallboard hangers, extension rings, fixture studs, grounding connection, cable clamps, metal straps for supporting outlet boxes, etc. shall be compatible with outlet boxes being used and fulfilling requirements of individual wiring situations.

F. Exposed or surface mounted boxes, when used with rigid steel conduits, shall have threaded hubs. These boxes shall be cast from feraloy or malleable iron, hot-dip galvanized.

2.05 WEATHERPROOF OUTLET BOXES

A. All weatherproof outlet boxes shall comply with BS.

B. Provide corrosion-resistant cast metal weatherproof outlet wiring boxes of types, shapes, sizes and depths to suit each location and installation as shown on the Drawings.

C. Weatherproof outlet boxes shall be provided with threaded conduit ends, brass terminal with screw for ground connection, cast metal face plates with spring-hinged waterproof caps, suitable configures for each application, including face plate gaskets and corrosion resistant fasteners.

D. All weatherproof outlet boxes shall be provided with corrosion free epoxy powder coat, to provide corrosion resistance with appropriate gasket.

E. For outdoor applications and areas with corrosive atmosphere, boxes for use with PVC coated steel conduits shall be galvanized cast boxes with a PVC factory applied coating of 40 mm minimum thickness. Boxes shall have hubs with extruded sleeves extending the hubs.

2.06 JUNCTION/PULL BOXES AND CABINETS

A. All junction and pull boxes shall be constructed in compliance with BS.

B. Provide galvanized, code gauge sheet steel junction and pull boxes with screws on cover, of types, shapes, sizes and depths to suit each respective location and installation.

C. Junction/pull boxes and cabinets shall be provided with welded seams and appropriate cast covers, equipped with stainless steel nuts, bolts, screws, washers and brass terminal with screw for ground connection.

D. Junction/pull boxes and cabinets/enclosures shall be provided with hinged covers, where required.

E. Cabinets shall be provided with a reinforced steel back plate for mounting interior components, rigidity and accurate alignment.

2.07 CONDUIT BODIES

A. All conduit bodies such as capped elbows and service entrance elbows shall be constructed in compliance with BS.

B. Conduit bodies and covers shall be constructed from the same material and shall have the same finish or protective coating as that of associated conduits.

C. Provide galvanized conduit bodies of types, shapes and sizes to suit respective locations and installation, with thread corrosion-resistant screws for fixing.

D. The conduit bodies shall be appropriately threaded for the conduits and equipped with corrosion resistant screws for fixing the inspection cover.

E. Weatherproof conduit bodies and covers shall be provided with corrosion free epoxy powder coat, to provide resistance again corrosion. Covers shall be casketed.

2.10 FITTINGS

A. Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, covers of types and sizes to suit respective uses and installation.

B. Covers of junction/pull boxes, cabinets/enclosures, etc. shall be of the same thickness and material as that of the box and shall be reinforced where required due to large size. Screws for covers shall be stainless steel or high quality brass.

PART 3 EXECUTION

3.01 RACEWAYS

3.01.1 INSPECTION

A. All Electrical Raceways including conduits and fittings shall be free from objectionable lines, striations, bubbles, welds, and other manufacturing defects that would impair the service of the raceways. The bore of the conduits shall be circular in cross-section with smooth interior surfaces free from rough and flaky areas. The electrical raceways and fittings shall be free from all substances that injuriously effect any wire or cable covering.

B. All the Electrical Raceways including conduit runs are shown diagrammatically on the Drawings to outline the general routing only. Any interference with pipes, HVAC ducts, structural members or other equipment shall be inspected and coordinated well before commencement of the installation of raceways. Deviations shall be made in accordance with the approval of the Engineer, at no extra cost to the Contract.

3.01.2 PVC CONDUITs INSTALLATION

A. PVC conduits shall be used only where concealed, cast into slabs, built or chased into walls etc. Where conduits are surface run in ceiling voids, shaft spaces, plant rooms etc. galvanised RSC shall be used. Adaptation between PVC and metal conduits shall be through metal boxes.

B. PVC conduits shall not be installed in locations exposed to direct sun light.

C. Where conduit boxes are not to be fitted with accessories, they shall be fitted with cover plates which shall be overlapping where flush boxes are used.

D. PVC conduits shall be jointed and terminated utilizing the following appropriate components as supplied by the conduit manufacturer:

1. Purpose made adaptors and accessories.
2. Permanent adhesive - Solvent cement to produce a rigid watertight joint when used with standard couplers and accessories.

3. Flexible adhesive - A non-hardening adhesive to be used where expansion facilities are required in long conduit runs, in conjunction with expansion coupler. Not to be used at building movement joints.

E. PVC conduits up to 25 mm diameter may be bent cold with the use of the appropriate bending spring obtained from the conduit manufacturer. For larger size conduits, it is necessary to use heat or appropriate manufacturer's standard ready made bends.

F. Adequate allowance shall be made for linear expansion and contraction of the conduits under normal working temperature variations, as follows:

1. Expansion couplers shall be used on all straight runs of conduit exceeding 6 m in length.
2. Conduit shall be free to slide within saddles.
3. Allowance for expansion in cast in-situ installation is normally only required to effect structural movement at building expansion joints.

G. Conduit shall be supported at intervals of 1.5 m in isolated positions or 1 m in accessible situations. Where working temperatures are high, this spacing shall be reduced accordingly.

H. Multiple conduits may necessitate the use of large PVC adaptable boxes for junctions, which shall be readily accessible at all times.

I. Care shall be taken in the support of totally enclosed lighting fittings. Where excessive temperatures are likely to occur, special heat resistant boxes shall be used, i.e. of a pattern specifically designed to improve weight loading characteristics at high temperatures.

J. Spacing (fill) factors shall be applied to all conduits in accordance with 522-08 of the IEE Wiring Regulations, 16th Edition (BS7671).

K. Do not install PVC conduits closer than 75 mm to pipes of other services.

L. "Draw-in" boxes shall be installed in all conduit runs exceeding 3 m in length at a maximum 12 m spacing and shall be readily accessible at all times.

M. Inspection elbows, bends or tees shall not be permitted for flush installation.

N. Use extension rings where boxes are found to be not flush with the finished surface. Care shall be taken to prevent water, dirt, dust or debris from entering the conduit system.

O. All bends shall be made so that the PVC conduits shall not be damaged, and the internal diameter of the conduits shall not be effectively reduced.

P. Not more than four 90 degree bends nor a total of 360 degree bends shall be made in one conduit run between outlets, fittings or outlet bodies including any bends located immediately at the start or end.

Q. Install concealed conduits such that only two crossings at a given point are allowed within the slab to prevent any damage or cracking of slab.

R. No conduit shall be allowed to run in the floor screed of toilets, kitchen, bathroom or any other wet area.

S. Where cables pass through ducts or sleeves entering buildings, seal the ends of the ducts or sleeves using a special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 °C, and shall not slump up to a temperature of 149 °C or less. It shall not be hardened materially when exposed to air.

3.01.3 METAL CONDUIT INSTALLATION

A. Metal conduits either Rigid Steel Conduits (RSC) shall be installed in exposed locations as required. RCS shall be installed exposed on surface at all such locations where conduits are liable to be damaged mechanically.

B. Threads for RSCs shall be of sufficient length to allow conduits to butt together within couplers. A minimum engagement of five (5) full threads shall be made at all fittings and accessories.

C. Remove oil and grease from all threads of RSCs.

D. Support all metal conduits at intervals of 1.5 m in isolated positions or 1 m in accessible situations.

E. Do not install metal conduit closer than 75 mm to pipes of other services.

F. All conduit boxes not to be fitted with accessories shall have metal cover plates which shall be overlapping where flush boxes are used.

G. 'Draw in' boxes shall be provided in conduit runs exceeding 3 m in length. 'Draw in' boxes shall be at a maximum 12 m spacing and readily accessible at all times. Adaptable junction boxes shall also be accessible at all times for inspection and maintenance.

H. Exercise care shall be taken to prevent water, dirt and debris from entering the conduit system.

I. Use extension rings where boxes are found not to be flush with the finished surface.

J. Protect conduits and conduit accessories from rust and mechanical damage. Exposed conduit threads and damaged or rusty portion of metal conduits shall be painted, using an oxide undercoat and aluminum paint, after being cleaned to bare metal.

K. Conduits installed in areas subject to corrosive atmospheres shall be painted with chlorinated rubber paint after the installation is complete.

L. Under no circumstances, shall any metal conduit be used as a circuit protective conductor (CPC). Every final sub-circuit shall incorporate its own separate Cu/PVC CPC.

M. Spacing (fill) factors shall be applied to all conduits in accordance with 522-08 of the IEE Wiring Regulations, 16th Edition (BS7671).

N. Field bends shall be made with a hand bender for 1-1/2” (38mm) and smaller diameter metal conduits only. Larger size conduits shall be bent with a machine bender or be factory supplied. Heating of metal conduits to facilitate bending is not permitted.

O. All bends shall be made so that metal conduits shall not be damaged, and the internal diameter of the conduit shall not be effectively reduced. The inner edge radius of all field bends shall not be less than the minimum allowable radius as BS.

P. Not more than four 90 degree bends nor a total of 360 degree bends shall be made in one conduit run between outlets, fittings or outlet bodies including any bends located immediately at the start or end.

Q. Conduits and elbow used for cables extending to outside of building shall be PVC coated rigid steel extending one meter from building foundation. A concrete encased PVC adapter shall be used in case cable extending will run in PVC ducts. Bells shall be provided on PVC horizontal stub outs.

R. PVC conduits shall not be extended above grade. Where extensions of PVC conduits above grade are required, a PVC coated rigid steel transition bend having PVC/steel coupling on one end and threaded male or female adaptor on the other end. The PVC coated rigid steel transition bend or conduit shall extend minimum 150 mm above grade. A concrete envelope 100 mm high shall be formed around such risers to minimize corrosion at point of emergence. The top of the envelope shall be sloped for drainage.

S. Verify exact stub up location and termination requirement for items and equipment being served, for all necessary power and control wiring.

T. Where cables pass through ducts or sleeves entering buildings, seal the ends of the ducts or sleeves using a special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 ^{o}C, and shall not slump upto a temperature of 149 ^{o}C or less. It shall not be hardened materially when exposed to air.

U. Where conduits turn out of, or penetrate, a slab, they shall be not less than 65 mm on centers.

V. Location and sizing of conduit sleeves passing through floors and walls that are not shown on the Drawings shall be the responsibility of the Contractor. All sleeves shall be rigid galvanized steel unless indicated otherwise, extended 150 mm above floor and capped when not in use. Space between conduits and sleeves shall be filled with ductseal to a minimum of 50 mm deep at top and bottom of conduit sleeve.

W. All metal conduits entering any gasketed boxes or gasketed equipment enclosure shall be provided and terminated with gasketed hubs with bonding screws. Whereas the metal conduits entering non-gasketed sheet-metal boxes or enclosures shall be provided and terminated with general purpose hubs.

X. Provide supports to alleviate stress on cables where they enter a conduit or other enclosure from the tray.

3.01.4 FLEXIBLE CONDUITs INSTALLATION

A. All flexible conduits and fittings used shall be liquid-tight.

B. Flexible conduits shall only be used in short lengths, of less than 1000 mm, in cases where a final connection is required to be made to a fixed item of equipment which is subject to vibration or thermal expansion.

C. Flexible conduits shall be 1.25 x L in length, L being the direct distance between connection unit and fixed appliance, up to maximum length of 1 m.

D. Purpose made glands shall be used on the ends of all lengths of flexible conduits.

E. A separate Cu/PVC circuit protective conductor shall be included in all lengths of flexible conduits.

F. Flexible conduits shall be installed so as not to incur undue mechanical strain, damage or excessive temperatures.

3.02 BOXES

3.02.1 PREPARATION

A. Determine exact locations of outlets on site after co-ordination with layouts for architectural, furniture and other equipment.

B. The locations of junction/pull boxes and other fittings and accessories are generally not shown on the Drawings, but Contractor shall provide these in compliance with applicable requirements of IEE Wiring Regulations, ease of maintenance, manufacturer's written instructions and recognized industry practices.

3.02.2 INSTALLATION

A. Install all electrical boxes and fittings in accordance with IEE Wiring Regulations.

B. Coordinate installation of electrical boxes and fitting with wire/cable and raceway installation work.

C. Provide knockout closures in all types of electrical boxes to cap unused knockout holes where blanks have been removed.

D. Install all types of boxes and conduit bodies at accessible locations to ensure easy installation and maintenance of electrical wiring.

E. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surface.

F. Fasten boxes rigidly to substrate or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

G. Provide electrical and earth connections for all types of installed electrical boxes.

H. Fastenings for all types of exposed/surface mounted electrical boxes shall not penetrate more than 30 mm into reinforced concrete beams or more than 20 mm into reinforced concrete joists and shall not contact main reinforcing steel.

I. Boxes and supports shall be fastened with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work.

J. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support. Support cast metal boxes having thread less connectors and sheet metal boxes directly from the building structure or with bar hangers.

K. Where conduit supported outlet boxes are installed and conduit suspended from the structure with hangers, attach hangers to raceways on opposite sides of the box and shall be supported with an approved type fastener not more than 1 m measured each side from the box.

L. Boxes installed outdoor on concrete or masonry walls, for vapor tight fixtures, shall be weatherproof type.

M. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture or where shown on the Drawings.

N. Interior or weatherproof outlet boxes shall be provided for each light fixture, receptacle, equipment connection and other conduit termination points.

O. In suspended ceilings where outlet boxes support fixtures in which the ceiling suspension system does not have sufficient strength to prevent visible deflection of the ceiling surfaces, the boxes shall be supported by structural members, secured to building structure.

P. Outlet box covers shall not be used to support fixtures.

Q. Requirement of pull boxes shall be determined based on maximum allowable conduit runs, as described in Section 16140.

R. Where pull boxes (existing and new), are connected to conduits running underground in the site, they shall be provided with suitable provisions for drain.

3.03.1 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with STI fire stop.

B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.

C. Locate outlet boxes to allow luminaries positioned as indicated on Drawings reflected ceiling plan.

D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.03.2 ADJUSTING

A. Execution Requirements: Testing, adjusting, and balancing.

B. Adjust flush-mounting outlets to make front flush with finished wall material.

C. Install knockout closures in unused openings in boxes.

3.03.3 CLEANING

A. Execution Requirements: Final cleaning.

B. Clean interior of boxes to remove dust, debris, and other material.

C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION – 16130
ELECTRICAL RACEWAY BOXES/FITTINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical Raceways, accessories and Boxes / Fittings including, but not limited to, the following:

1. PVC Conduits.
2. Rigid Steel Conduits.
3. Flexible Conduits.
4. Interior outlet boxes.
5. Weatherproof outlet boxes.
6. Junction/pull boxes and cabinets.
7. Floor boxes.
8. Conduit bodies.
9. Fittings.

1.02 RELATED SECTIONS

H.	Section 16050	Electrical Works, General.
I.	Section 16075	Electrical Identification.
J.	Section 16120	LV Cables and Wires.
K.	Section 16070	Equipment Connections and Supports.
L.	Section 16134	Underground Electrical Services.
M.	Section 16150	Wiring Devices.

1.03 REFERENCES

A. The IEE Wiring Regulations, 17th Edition (2001).

B. BS 4568 Rigid Steel Conduits, Zinc Coated.

C. BS 6099-2.2 / IEC 614-2-2 U.P.V.C. Rigid Conduits.

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.
4. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
5. Technical performance of the equipment selected.
6. Dimensional details needed for installation and maintenance.
7. Control schematics and wiring diagrams.
8. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of raceways of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and agents/suppliers.

B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.

C. ELECTRICAL RACEWAYS SHALL GENERALLY BE MANUFACTURER'S STANDARD CONSTRUCTION AND MATERIALS. WHERE THIS CONTRADICTS ANY PART OF THE SPECIFICATIONS, THE CONTRACTOR SHALL STATE SO AT THE TIME OF TENDER.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide colour-coded thread protectors on the exposed threads of metal conduit, handle raceways carefully to prevent end-damage and avoid scoring the finishes.

B. Where possible the raceways shall be stored indoors. If necessary to store outdoors, the raceways shall be elevated well above ground and enclosed with durable waterproof wrapping.

PART 2 PRODUCTS

2.01 PVC CONDUITS

A. All PVC conduits and fittings shall be uPVC heavy gauge, rigid, direct buried or encased buried type as applicable, complying with BS 6099-2.2 / IEC 614-2-2 heavy gauge in all respects, and may be used where ambient temperatures do not exceed 75 °C.

B. All PVC conduits and accessories shall be obtained from the same manufacturer.

C. No conduit shall be less than 20 mm diameter.

D. Fittings and accessories for PVC conduits shall include, but not be limited to, the adapters, junction/pull boxes, bushings, couplings, elbows, nipples, plugs, seals, etc.

E. Conduit boxes shall be of the circular pattern with appropriate spout entries and 50.8 mm accessory fixing centres.

F. All connections and terminations of the PVC conduits and fittings shall be by means of the manufacturer's standard adaptor.

G. All boxes shall have brass thread inserts for the fixing of accessories or covers.

H. All tees shall be made using conduit tee boxes. Tangential entry boxes shall be used where appropriate. Multiple conduits may necessitate the use of large uPVC adaptable boxes for junctions.

I. All saddles shall be of the spacer bar type and from the same manufacturer as that of the conduit which they are being used to secure.

J. All wall mounted accessory boxes shall have one adjustable fixing lug to facilitate final leveling of accessories.

2.02 RIGID STEEL CONDUITS (rsc)

A. All Rigid Steel Conduits (RSC) and accessories shall be heavy gauge welded steel complying with BS 4568, not less than 20 mm diameter.

B. RSC and fittings shall be hot dipped galvanized, complying with BS 4568, providing heavy protection both inside and outside. The steel shall be galvanized after cutting and threading.

C. All conduits and fittings shall be threaded, free from rust or other defects and shall have same hot dipped galvanized finish throughout the installation.

D. Fittings and accessories for RSC shall include, but not be limited to, adapters, junction/pull boxes, bushings, connectors, couplings, elbows, expansion joints, gaskets, hubs, locknuts, nipples, plugs, seals, breathers, etc.

E. Fittings and accessories for RSC shall be of malleable iron or a mixture of grey iron and cast steel.

F. All bushes shall be hexagonal headed, heavy duty, long threaded brass bushes complete with serrated tempered shakeproof washers. All bends shall be cold set. All tees shall be made using circular tee conduit boxes.

G. All saddles for surface mounted installation of RSC shall be of the spacer bar type and of the same

finish as that of the conduit which they are being used to secure.

H. A tapped earth connection facility shall be provided in every box.

I. All accessory boxes shall have one adjustable fixing lug to facilitate final levelling of accessory.

J. PVC coated RSC and fittings shall be used for cables extending to outside of building and where above grade extensions of PVC Conduits required a transition from PVC to RSC.

2.03 FLEXIBLE CONDUITS

A. Flexible conduits shall be liquid-tight, constructed from galvanized steel core and continuous liquid-tight PVC jacket in accordance with BS 731 Part 1, not less than 20 mm diameter.

B. Flexible conduit shall only to be used for final connection to items of fixed equipment subject to vibration or movement.

C. All flexible conduits shall have a liquid-tight PVC jacket capable of withstanding 90 °C cable operating temperatures.

D. All fittings and accessories for liquid-tight flexible steel conduits shall be nylon jacketed.

E. Nylon jacketed brass adaptors shall be provided for connection at either end of the flexible conduit and should be of the compression type.

2.04 INTERIOR OUTLET BOXES

A. All interior outlet boxes shall be constructed in compliance with BS.

B. Provide galvanized flat, rolled sheet steel interior outlets and switches wiring boxes of types, shapes, sizes and depths to suit each respective location and installation. Construct threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.

C. Terminal with screw shall be provided inside the box for grounding connection of all metallic outlet boxes with appropriate earth mark.

D. Accessories for interior outlet boxes such as mounted brackets, wallboard hangers, extension rings, fixture studs, grounding connection, cable clamps, metal straps for supporting outlet boxes, etc. shall be compatible with outlet boxes being used and fulfilling requirements of individual wiring situations.

E. Exposed or surface mounted boxes, when used with rigid steel conduits, shall have threaded hubs. These boxes shall be cast from feraloy or malleable iron, hot-dip galvanized.

2.05 WEATHERPROOF OUTLET BOXES

A. All weatherproof outlet boxes shall comply with BS.

B. Provide corrosion-resistant cast metal weatherproof outlet wiring boxes of types, shapes, sizes and depths to suit each location and installation as shown on the Drawings.

C. Weatherproof outlet boxes shall be provided with threaded conduit ends, terminal with screw for ground connection, cast metal face plates with spring-hinged waterproof caps, suitable configures for each application, including face plate gaskets and corrosion resistant fasteners.

D. All weatherproof outlet boxes shall be provided with corrosion free epoxy powder coat, to provide corrosion resistance with appropriate gasket.

E. For outdoor applications and areas with corrosive atmosphere, boxes for use with PVC coated steel conduits shall be galvanized cast boxes with a PVC factory applied coating of 40 mm minimum thickness. Boxes shall have hubs with extruded sleeves extending the hubs.

2.06 JUNCTION/PULL BOXES AND CABINETS

A. All junction and pull boxes shall be constructed in compliance with BS.

B. Provide galvanized, code gauge sheet steel junction and pull boxes with screws on cover, of types, shapes, sizes and depths to suit each respective location and installation.

C. Junction/pull boxes and cabinets shall be provided with welded seams and appropriate cast covers, equipped with stainless steel nuts, bolts, screws, washers and terminal with screw for ground connection.

D. Junction/pull boxes and cabinets/enclosures shall be provided with hinged covers, where required.

E. Cabinets shall be provided with a reinforced steel back plate for mounting interior components, rigidity and accurate alignment.

2.10 FLOOR BOXES

A. All floor outlet boxes shall be metallic and constructed in compliance with BS.

B. Provide corrosion resistant, galvanized, sheet steel floor outlet boxes of the types, shapes, sizes and depths to suit each respective location and installation.

C. The depth of floor outlet boxes shall be sufficient enough to accommodate conduit entries from sides and all kind of wiring devices with plugs from the top.

D. The floor outlet boxes shall be waterproof when fully closed. Appropriate rubber protection shall be available for cable outlets from the floor base.

E. The cover of the floor outlet boxes shall be able to be closed completely after installation of plugs and connecting devices inside the box. The cover shall be suitable for flush floor installation with provision of fixing carpet, vinyl sheet, etc. above the cover to match with the finish of the floor.

F. Floor boxes shall have a panel opening and overall module depth shall be suitable for the required compartments. The box must provided with total Device Wiring Chamber.

G. The box lid shall be a hinged style and constructed of polycarbonate material, available in standard colors of black, brown and gray. The lid shall provide a minimum of three removable cable guards for egress of power and communication workstation cables. The cable guards shall hold workstation cables in place with the lid either in the open or closed position.

H. The trim flange shall be constructed of polycarbonate material. The hinged lid and trim flange shall be available for either carpet or tile floor applications.

I. The wiring chamber shall provide an upper and a lower compartment. The top compartment shall be divided into four separate compartments to accommodate a combination of both power and communication wiring as indicated on drawings. These compartments shall be separated by use of integral; die cast aluminum built in dividers. The bottom compartment shall be available for either all power or all communication wiring.

J. The box shall be secured to the raised floor by the use of two locking tabs. The locking tabs shall be integral to the box and adjusted by use of their locking screws.

2.11 CONDUIT BODIES

A. All conduit bodies such as capped elbows and service entrance elbows shall be constructed in compliance with BS.

B. Conduit bodies and covers shall be constructed from the same material and shall have the same finish or protective coating as that of associated conduits.

C. Provide galvanized conduit bodies of types, shapes and sizes to suit respective locations and installation, with thread corrosion-resistant screws forfixing.

D. The conduit bodies shall be appropriately threaded for the conduits and equipped with corrosion resistant screws for fixing the inspection cover.

E. Weatherproof conduit bodies and covers shall be provided with corrosion free epoxy powder coat, to provide resistance again corrosion. Covers shall be gasketted.

2.12 FITTINGS

A. Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, covers of types and sizes to suit respective uses and installation.

B. Covers of junction/pull boxes, cabinets/enclosures, etc. shall be of the same thickness and material as that of the box and shall be reinforced where required due to large size. Screws for covers shall be stainless steel or high quality brass.

PART 3 EXECUTION

3.01 RACEWAYS

3.01.1 INSPECTION

A. All Electrical Raceways including conduits and fittings shall be free from objectionable lines, striations, bubbles, welds, and other manufacturing defects that would impair the service of the raceways. The bore of the conduits shall be circular in cross-section with smooth interior surfaces free from rough and flaky areas. The electrical raceways and fittings shall be free from all substances that injuriously effect any wire or cable covering.

B. All the Electrical Raceways including conduit runs are shown diagrammatically on the Drawings to outline the general routing only. Any interference with pipes, HVAC ducts, structural members or other equipment shall be inspected and coordinated well before commencement of the installation of raceways. Deviations shall be made in accordance with the approval of the Engineer, at no extra cost to the Contract.

3.01.2 PVC CONDUITs INSTALLATION

A. PVC conduits shall be used only where concealed, cast into slabs, built or chased into walls etc. Where conduits are surface run in ceiling voids, shaft spaces, plant rooms etc. galvanised RSC shall be used. Adaptation between PVC and metal conduits shall be through metal boxes.

B. PVC conduits shall not be installed in locations exposed to direct sun light.

C. Where conduit boxes are not to be fitted with accessories, they shall be fitted with cover plates which shall be overlapping where flush boxes are used.

D. PVC conduits shall be jointed and terminated utilising the following appropriate components as supplied by the conduit manufacturer:
   4. Purpose made adaptors and accessories.
   5. Permanent adhesive - Solvent cement to produce a rigid watertight joint when used with standard couplers and accessories.
   6. Flexible adhesive - A non-hardening adhesive to be used where expansion facilities are required in long conduit runs, in conjunction with expansion coupler. Not to be used at building movement joints.

E. PVC conduits up to 25 mm diameter may be bent cold with the use of the appropriate bending spring obtained from the conduit manufacturer. For larger size conduits, it is necessary to use heat or appropriate manufacturer's standard ready made bends.

F. Adequate allowance shall be made for linear expansion and contraction of the conduits under normal working temperature variations, as follows:
   4. Expansion couplers shall be used on all straight runs of conduit exceeding 6 m in length.
   5. Conduit shall be free to slide within saddles.
   6. Allowance for expansion in cast in-situ installation is normally only required to effect structural movement at building expansion joints.

G. Conduit shall be supported at intervals of 1.5 m in isolated positions or 1 m in accessible situations. Where working temperatures are high, this spacing shall be reduced accordingly.

H. Multiple conduits may necessitate the use of large PVC adaptable boxes for junctions, which shall be readily accessible at all times.

I. Care shall be taken in the support of totally enclosed lighting fittings. Where excessive temperatures are likely to occur, special heat resistant boxes shall be used, i.e. of a pattern specifically designed to improve weight loading characteristics at high temperatures.

J. Spacing (fill) factors shall be applied to all conduit in accordance with 522-08 of the IEE Wiring Regulations, 17th Edition (BS7671).

K. Do not install PVC conduits closer than 75 mm to pipes of other services.

L. "Draw-in" boxes shall be installed in all conduit runs exceeding 3 m in length at a maximum 12 m spacing and shall be readily accessible at all times.

M. Inspection elbows, bends or tees shall not be permitted for flush installation.

N. Use extension rings where boxes are found to be not flush with the finished surface. Care shall be taken to prevent water, dirt, dust or debris from entering the conduit system.

O. All bends shall be made so that the PVC conduits shall not be damaged, and the internal diameter of the conduits shall not be effectively reduced.

P. Not more than four 90 degree bends nor a total of 360 degree bends shall be made in one conduit run between outlets, fittings or outlet bodies including any bends located immediately at the start or end.

Q. Install concealed conduits such that only two crossings at a given point are allowed within the slab to prevent any damage or cracking of slab.

R. No conduit shall be allowed to run in the floor screed of toilets, kitchen, bathroom or any other wet area.

S. Where cables pass through ducts or sleeves entering buildings, seal the ends of the ducts or sleeves using a special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 oC, and shall not slump upto a temperature of 149 oC or less. It shall not be hardened materially when exposed to air.

3.01.3 METAL CONDUIT INSTALLATION

A. Metal conduits either Rigid Steel Conduits (RSC) shall be installed in exposed locations as required. RCS shall be installed exposed on surface at all such locations where conduits are liable to be damaged mechanically.

B. Threads for RSCs shall be of sufficient length to allow conduits to butt together within couplers. A minimum engagement of five (5) full threads shall be made at all fittings and accessories.

C. Remove oil and grease from all threads of RSCs.

D. Support all metal conduits at intervals of 1.5 m in isolated positions or 1 m in accessible situations.

E. Do not install metal conduit closer than 75 mm to pipes of other services.

F. All conduit boxes not to be fitted with accessories shall have metal cover plates which shall be overlapping where flush boxes are used.

G. 'Draw in' boxes shall be provided in conduit runs exceeding 3 m in length. 'Draw in' boxes shall be at a maximum 12 m spacing and readily accessible at all times. Adaptable junction boxes shall also be accessible at all times for inspection and maintenance.

H. Exercise care shall be taken to prevent water, dirt and debris from entering the conduit system.

I. Use extension rings where boxes are found not to be flush with the finished surface.

J. Protect conduits and conduit accessories from rust and mechanical damage. Exposed conduit threads and damaged or rusty portion of metal conduits shall be painted, using an oxide undercoat and aluminium paint, after being cleaned to bare metal.

K. Conduits installed in areas subject to corrosive atmospheres shall be painted with chlorinated rubber paint after the installation is complete.

L. Under no circumstances, shall any metal conduit be used as a circuit protective conductor (CPC). Every final sub-circuit shall incorporate its own separate Cu/PVC CPC.

M. Spacing (fill) factors shall be applied to all conduits in accordance with 522-08 of the IEE Wiring Regulations, 17th Edition (BS7671).

N. Field bends shall be made with a hand bender for 1-1/2” (38mm) and smaller diameter metal conduits only. Larger size conduits shall be bent with a machine bender or be factory supplied. Heating of metal conduits to facilitate bending is not permitted.

O. All bends shall be made so that metal conduits shall not be damaged, and the internal diameter of the conduit shall not be effectively reduced. The inner edge radius of all field bends shall not be less than the minimum allowable radius as BS.

P. Not more than four 90 degree bends nor a total of 360 degree bends shall be made in one conduit run between outlets, fittings or outlet bodies including any bends located immediately at the start or end.

Q. Conduits and elbow used for cables extending to outside of building shall be PVC coated rigid steel extending one meter from building foundation. A concrete encased PVC adapter shall be used in case cable extending will run in PVC ducts. Bells shall be provided on PVC horizontal stub outs.

R. PVC conduits shall not be extended above grade. Where extensions of PVC conduits above grade are required, a PVC coated rigid steel transition bend having PVC/steel coupling on one end and

threaded male or female adaptor on the other end. The PVC coated rigid steel transition bend or conduit shall extend minimum 150 mm above grade. A concrete envelope 100 mm high shall be formed around such risers to minimize corrosion at point of emergence. The top of the envelope shall be sloped for drainage.

S. Verify exact stub up location and termination requirement for items and equipment being served, for all necessary power and control wiring.

T. Where cables pass through ducts or sleeves entering buildings, seal the ends of the ducts or sleeves using a special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 ^{o}C, and shall not slump upto a temperature of 149 ^{o}C or less. It shall not be hardened materially when exposed to air.

U. Where conduits turn out of, or penetrate, a slab, they shall be not less than 65 mm on centers.

V. Location and sizing of conduit sleeves passing through floors and walls that are not shown on the Drawings shall be the responsibility of the Contractor. All sleeves shall be rigid galvanized steel unless indicated otherwise, extended 150 mm above floor and capped when not in use. Space between conduits and sleeves shall be filled with ductseal to a minimum of 50 mm deep at top and bottom of conduit sleeve.

W. All metal conduits entering any gasketed boxes or gasketed equipment enclosure shall be provided and terminated with gasketed hubs with bonding screws. Whereas the metal conduits entering non-gasketed sheet-metal boxes or enclosures shall be provided and terminated with general purpose hubs.

X. Provide supports to alleviate stress on cables where they enter a conduit or other enclosure from the tray.

3.01.4 FLEXIBLE CONDUITs INSTALLATION

A. All flexible conduits and fittings used shall be liquid-tight.

B. Flexible conduits shall only be used in short lengths, of less than 1000 mm, in cases where a final connection is required to be made to a fixed item of equipment which is subject to vibration or thermal expansion.

C. Flexible conduits shall be 1.25 x L in length, L being the direct distance between connection unit and fixed appliance, up to maximum length of 1 m.

D. Purpose made glands shall be used on the ends of all lengths of flexible conduits.

E. A separate Cu/PVC circuit protective conductor shall be included in all lengths of flexible conduits.

F. Flexible conduits shall be installed so as not to incur undue mechanical strain, damage or excessive temperatures.

3.02 BOXES

3.02.1 PREPARATION

A. Determine exact locations of outlets on site after co-ordination with layouts for architectural, furniture and other equipment.

B. The locations of junction/pull boxes and other fittings and accessories are generally not shown on the Drawings, but Contractor shall provide these in compliance with applicable requirements of IEE Wiring Regulations, ease of maintenance, manufacturer's written instructions and recognized industry practices.

3.02.2 INSTALLATION

A. Install all electrical boxes and fittings in accordance with IEE Wiring Regulations.

B. Coordinate installation of electrical boxes and fitting with wire/cable and raceway installation work.Provide knockout closures in all types of electrical boxes to cap unused knockout holes where blanks have been removed.

C. Install all types of boxes and conduit bodies at accessible locations to ensure easy installation and maintenance of electrical wiring.

D. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surface.

E. Fasten boxes rigidly to substrate or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

F. Provide electrical and earth connections for all types of installed electrical boxes.

G. Fastenings for all types of exposed/surface mounted electrical boxes shall not penetrate more than 30 mm into reinforced concrete beams or more than 20 mm into reinforced concrete joists and shall not contact main reinforcing steel.

H. Boxes and supports shall be fastened with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work.

I. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support. Support cast metal boxes having threadless connectors and sheet metal boxes directly from the building structure or with bar hangers.

J. Where conduit supported outlet boxes are installed and conduit suspended from the structure with hangers, attach hangers to raceways on opposite sides of the box and shall be supported with an approved type fastener not more than 1 m measured each side from the box.

K. Boxes installed outdoor on concrete or masonry walls, for vaportight fixtures, shall be weatherproof type.

L. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture or where shown on the Drawings.

M. Interior or weatherproof outlet boxes shall be provided for each light fixture, receptacle, equipment connection and other conduit termination points.

N. In suspended ceilings where outlet boxes support fixtures in which the ceiling suspension system does not have sufficient strength to prevent visible deflection of the ceiling surfaces, the boxes shall be supported by structural members, secured to building structure.

O. Outlet box covers shall not be used to supportfixtures.

P. Requirement of pull boxes shall be determined based on maximum allowable conduit runs, as described in Section 16140.

Q. Where pull boxes (existing and new), are connected to conduits running underground in the site, they shall be provided with suitable provisionsfor drain.

END OF SECTION

SECTION 16133
CABLE TRAYS, LADDERS & TRUNKS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cable trays (perforated and /or solid)

B. Cable Ladders

1.02 RELATED SECTIONS

A. Related Sections:

22. Section 16060 - Grounding and Bonding for Electrical Systems.
23. Section 16070 - Hangers and Supports for Electrical Systems

1.03 REFERENCES

A. BS EN ISO 1461

1.04 SUBMITTALS

D. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.

E. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.

F. Product Data: Submit fittings and accessories.

G. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Cable Trays shall comply with the applicable standards of Local Standards Organization and BS.

C. Any defects or damage caused partly or wholly in the installation of cable trays to the building or building fabric shall be made good to the satisfaction of the Engineer.

D. Source Limitations: Obtain cable tray components through one source from a single Manufacturer.

1.06 DELIVERY, STORAGE AND HANDLING

A. All Cable Trays shall be delivered in factory pack wrapping and boxes and stored in a clean, dry space within the racks.

1.07 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 PRODUCTS

2.01 CABLE TRAYS (perforated and /or solid)

A. All cable trays shall be of heavy duty perforated type with return flange.

B. Cable trays shall be perforated with epoxy coated, (HDG+E+P) According to ISO 1461: Special coating of minimum 70 microns of zinc coating, 100 microns of epoxy coating. & Final coating of "Super Durable" Polyester of 100 microns conforming the final color shading RAL 5017.

C. All accessories and fittings such as bends, tees, elbows, cross units and angles shall be of the same specification as that of the cable tray finish and shall be standard products from the same manufacturer as the cable tray. Site fabrication shall not be permitted.

D. Cable trays and accessories shall not less than 2.0 mm thickness.

E. All fixing brackets, nuts and bolts shall be finished by hot dip galvanising.

F. Tinned copper earth continuity straps shall be provided at every joint of the cable tray.

G. Where cable tray crosses building expansion joints, the tray shall be installed suitably to provide expansion / contraction with the building expansion.

H. Where cable tray carries 13.8 kV cable, a tray lid shall be installed.

I. In outdoor locations and areas subject to corrosive atmospheres, all cable trays shall be painted with chlorinated rubber paint or PVC/Epoxy coating, as approved by the Engineer.

2.02 CABLE LADDERS

A. All cable ladders shall be heavy duty gauge (>2 mm), manufactured from hot-dip galvanized steel with a standard heavy duty galvanizing coating of 350 g/m^2 and Z2 bending grade.

B. All accessories and fittings such as couplers, bends, tees, elbows, etc. shall be by the same manufacturer as the ladder.

C. Ladder system supports shall be determined in accordance with the manufacturer's structural information to ensure that undue stress or bending shall not occur.

D. Tinned copper earth straps shall be provided at every joint of cable ladders.

E. In outdoor locations and areas subject to corrosive atmosphere, the ladders shall be painted with chlorinated rubber paint or PVC/Epoxy coating, as approved by the Engineer.

2.03 SURFACE/FLOOR CABLE TRUNKING

A. Surface/floor cable trunking shall be used with prior approval of the Engineer, wherever possible to replace multiple conduit runs.

B. Metal surface/floor cable trunking shall comply with BS 4678 Part 1:Class 3 and shall be manufactured from galvanised steel sheets.

C. Only purpose made bends, tees, risers, end stops, fittings, connectors, covers and accessories by the same manufacturer as the trunking shall be used and finished in hot dipped galvanized steel. Site fabrication shall not be permitted.

D. Tinned copper earth straps shall be provided at every joint of the metal surface/floor trunking.

E. Covers for surface type cable trunking, suspended for fixed on surface of wall or under raised floor, shall be of the overlapping type and secured to the trunking by an approved type of fastening arrangement such as clips, etc.

F. In outdoor locations and areas subject to corrosive atmospheres, all trunking shall be painted with chlorinated rubber paint or PVC/Epoxy coating as approved by the Engineer.

G. Surface/Floor Cable trunking shall be single or multi-compartment as required. Where multi-compartment is used, vertical dividers shall be provided between the compartments which shall be welded to the trunking prior to galvanising.

J. Heavy Duty uPVC trunking with clip on lid (all insulated) shall be used, if shown on the Drawings or specified elsewhere, to replace multiple conduit runs. All PVC cable trunking and accessories shall be obtained from the same manufacturer. Only standard accessories fabricated by the manufacturer shall be used and no site fabrication shall be allowed.

K. Floor trunking and covers shall be standard products of an approved manufacturer with modular sections to provide flexibility of installation to suit any site situation. The floor trunking and cover shall be suitable for surface or embedded installation as per actual site requirements. The construction and dimensions of the floor trunking and cover for embedded installation shall match with the floor finishing pattern having special provision of accepting floor tiles, carpet, etc. within the recess of the cover provided in accordance with the site requirements.

2.04 WARNING SIGNS

A. Engraved Nameplates: black letters on yellow laminated plastic nameplate, engraved with: WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

PART 3 EXECUTION

3.01 INSTALLATION

3.01.1 SURFACE/FLOOR CABLE TRUNKING INSTALLATION

A. Cable trunking shall be fixed securely to the building structure at intervals not exceeding 1.5 m.

B. Where vertical runs of trunking exceed 3 m in length, pin racks shall be fitted.

C. Spacing (fill) factors shall be applied to all cable trunking in accordance with 522-08 of the IEE Wiring Regulations, 17th Edition (BS7671).

D. For metal trunking installations, earth continuity shall be ensured by means of tinned copper earth straps bolted across each joint. Flexible braided straps shall be used for expansion joints.

E. Metal trunking cut during installation shall have the cut ends painted with an oxide undercoat and an aluminium top coat.

F. Where metal trunking is installed in areas subject to corrosive atmospheres, the complete trunking installation shall be painted with a chlorinated rubber paint after the installation is complete.

G. Expansion joints with gaps shall be incorporated in all cable trunking runs in excess of 6 m in length. External couplings shall have elongated slots and fixing holes shall be drilled oversize to give freedom of linear movement. Internal couplings shall be securely fixed at one end by use of thixotrophic adhesive leaving the other end free for linear movement.

H. Bare copper or aluminium cables shall not be run in metal trunking.

3.01.2 CABLE TRAYS/LADDERS INSTALLATION

A. Where practical, cable trays/ladders shall be run horizontally and flat or vertically and shall be supported at distances not exceeding 1.5 m to the building structure using mild steel brackets. These brackets shall be secured to the building structure using expanded bolts and washers or built into the building structures during construction.

B. Where cable tray/ladder is suspended, 2 drop rods shall be used at each suspension point to an angle iron or channel support to which the cable ladder is bolted. The spacing of suspension points shall be determined in accordance with the manufacturer's structural information such that undue stress of defection does not occur.

C. Where cable tray/ladder is cut, the open ends shall be painted using an oxide undercoat and an aluminum top coat. Where the finish is PVC, a top coat of liquid PVC solution shall be applied after the completion of the cable ladder installation.

D. Cable trays/ladders run parallel with walls shall not be mounted closer than 75 mm to the wall.

E. All cables shall be secured to the cable tray with clamps at distances in accordance with 522-08 of the IEE Wiring Regulations, 17th Edition (BS7671).

F. Do not run bare copper or aluminum cables run on cable tray/ladder.

G. Ensure earth continuity by means of tinned copper earth straps bolted across each cable tray/ladder joint. Flexible braided straps shall be used for expansion joints.

H. Support trays and fasten to structure and finishes in accordance with hangers & supports for electrical systems specifications, Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of maximum.

I. Install expansion connectors where recommended by manufacturer as indicated on Drawings.

J. Install fire stopping in accordance with STI fire stop and section 16070 to sustain ratings when passing cable tray through fire-rated elements.

K. Ground and bond metal cable tray in accordance with Section 16060.

L. Provide continuity between tray components.

M. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.

N. Install 2.5 mm2PVC copper wire to maintain t grounding through entire length of tray; bond to each component.

O. Make connections to tray using mechanical, compression or exothermic connectors.

P. Install warning signs at centers along cable tray, located to be visible.

END OF SECTION

SECTION – 16134
UNDERGROUND ELECTRICAL SERVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Underground Electrical Services including, but not limited to the following:

1. Trenching and backfilling.
2. Duct banks.
3. Stub-ups.
4. Manholes, handholes and earth rod pits.
5. Concrete pads.
6. Cable warning signs and tapes.

1.02 RELATED SECTIONS

A.	Section 16050	Electrical Works, General
B.	Section 16075	Electrical Identification.
C.	Section 16120	LV Cables and Wires.
D.	Section 16130	Electrical Raceways and Boxes.
E.	Section 16070	Electrical Connections for Equipment.
F.	Section 16520	Exterior and Street Lighting.
G.	Section 16060	Grounding System.

1.03 REFERENCES

A. The IEE Wiring Regulations, 17th Edition (2001).
B. BS 4568 Rigid Steel Conduits, Zinc Coated.
C. BS 6099-2.2 / IEC 614-2-2U.P.V.C. Rigid Conduits.

1.04 SUBMITTAL

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country oforigin.
3. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan
4. Copies of test reports or certificates.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

1.05 QUALITY ASSURANCE

A. All items for underground electrical services shall be manufacturer's standard construction and materials except civil works such as excavation, backfilling and concreting. Where this contradicts any part of the Specifications, the Contractor shall state so at the time of tender.

B. Manufacturers: Firms regularly engaged in the manufacture of such items of the types and sizes required, and whose products have been in satisfactory use in similar service for a period not less than 5 years. Preference shall be given to local manufacturers.

C. All work shall conform to applicable standards of Local Standards Organization and BS.

D. All underground electrical services for power and communications shall comply with the requirements and standards of Electricity Supply Authority and Telecom Supplier respectively.

1.06 DELIVERY, STORAGE AND HANDLING

A. During unloading of PVC pipes and other items for underground electrical services, rough handling shall be avoided. Chains or wire ropes may be used, provided they are suitably covered, to protect the pipes and other items from damage.

B. Unloading by mechanical means such as a crane or fork lift may be used where PVC pipes and other items for underground electrical services are delivered in bundles or in crates. However, consideration shall be given to the total weight and the lifting capacity of the mechanical equipment, and the observance of the statutory safety requirements.

C. PVC pipes and other items for underground electrical services shall not be dropped or thrown to the ground, knocked against other conduits or against sharp objects that any cause permanent damage.

D. In preparing for laying the pipes in trenches, the pipes and fittings may be unloaded along the trench direct from the back of a truck. Ducts and fittings should be unloaded on the side opposite to backfill. Fittings including end bells, couplings and other accessories such as solvent cement and lubricant shall be stored at the trench site under cover to prevent loss or damage.

E. When storing on site, PVC pipes and other similar items shall be placed a level surface and shall be supported to minimize distortion, and protected from direct sunlight. Horizontal supports of adequate width shall be spaced not more than 1.5 m center to center beneath pipes to provide continuous and even support.

F. Vertical side supports shall be provided at 3 m spacing on rectangular stacks. The maximum free height of such stacks shall not exceed 1.5 m.

PART 2 PRODUCTS

2.01 GENERAL

A. Underground Electrical Services for power, lighting, low current systems, control cables and grounding shall comprise manholes and handholes interconnected via concrete encased PVC pipes, direct buried PVC pipes or cable trenching; all as shown on the Drawings and mentioned in the Specifications or required on site for proper installation and maintenance of electrical systems.

B. Any trenching, backfilling, compaction and general grading required for electrical works shall be carried out in accordance with the requirements.

C. Any metal frames, covers, louvers, etc. related to the works described under this Section shall be carried out in accordance with the requirements given in Section 02726.

D. Any cast in place concrete related to underground electrical services described under this Section shall be carried out in accordance with the specifications.

2.02 DUCT BANKS

A. Duct banks shall be either direct buried type or concrete encased type, as applicable and required on site.

B. Heavy duty rigid PVC conduits shall be used for direct buried or concrete encased underground duct systems. PVC conduits and fittings shall comply with the requirements of Section 16130

C. PVC conduit shall be suitable for a temperature range of 4 °C to 90 °C. Conduits within the duct bank shall be supported on plastic interlocking spacers, at intervals of approximately 2.4 m. A 25 mm minimum separation, edge to edge, shall be maintained, both horizontally and vertically, between the ducts.

D. All duct banks shall have a 75 mm concrete cover on the top, sides, and bottom of the PVC ducts. Anchorage shall be used to hold the ducts in place while pouring the concrete encasement.

E. Where the duct bank enters a building below ground level, the conduit shall terminate in an appropriate fitting. An end bell shall be used on conduits entering manholes.

F. After completion of the installation of cables in the duct bank, seal the ends of duct banks using special caulking compound of a putty-like consistency. It shall be workable with the hands at temperatures as low as 1.7 °C, and shall not slump up to a temperature of 149 °C. It shall not be harden significantly when exposed to air.

G. A run of conduit shall not contain more than the equivalent of four quarter bends. Bends in conduit shall be made without reducing the internal diameter of the conduit. The inside radius of the conduit bends shall not be less than one meter.

H. Matching end bells and plugs, constructed of high impact plastic, shall be provided through out the duct bank at the ends and in manholes.

I. Each length of conduit shall be provided with one standard coupling. Couplings shall have a center step to ensure proper seating. Joints shall be made with the solvent cement as recommended by the conduit manufacturer.

J. Concrete encasement shall be class C20 concrete with 13 mm maximum size aggregate for all duct banks. For warning purposes, a red dye shall be troweled into the top surface after pouring the concrete.

K. An expansion joint of 55 mm per 100 meters maximum shall be provided in the duct banks. Additionally, a construction joint shall be installed if pouring of concrete is commenced any time after initial set of adjacent concrete. Neither expansion nor construction joints shall be installed under a roadway.

L. For duct banks in stable soils, the soil below the duct bank shall be compacted to 90 % of maximum density to a minimum depth of 300 mm. A dewatering system shall be used to lower the water table below the final excavation depth to eliminate disturbance of in-situ soil densities.

2.03 STUB-UPs

A. Stubs-up for electrical equipment connections and other requirements shall consist of either 100 mm or 150 mm diameter hot double-dipped galvanized rigid steel conduit entirely encased in concrete or UPVC as specified in other sections.

B. PVC/Rigid steel conduits and bends for stub-ups shall comply with the requirements of Section 16130.

C. The bends for stub-ups shall be 90 degrees with a minimum radius of 1200 mm.

D. Bends for stub-ups shall serve as transition between PVC conduits embedded below grade and rigid steel conduit installed exposed on surface. Such bends shall be provided with a PVC steel coupling on one end and a threaded male or female adapter on the other end.

2.04 MANHOLES

A. Appropriate type and size of manholes shall be provided as shown on the Drawings or required on site in compliance with the requirements of Local Standards Organization, BS and Electricity supply authority or Telecom supplier regulations.

B. Manholes for communication and low current systems shall be constructed in accordance with the standard practice and requirements of Telecom Supplier. regulations.

C. A sump pit shall be built into the base slab directly beneath the manhole opening to collect and retain any water present in the manhole. Periodic maintenance may be required since sump pumps will not be permanently installed.

D. The duct bank manhole/interface shall include an expansion joint to take up longitudinal movement due to expansion and construction of the duct bank. This joint shall also act as water stop to prevent water from seeping inside the manhole.

E. The exterior of the manhole shall be waterproofed, with a bituminous coating.

F. Each manhole shall have two cable pulling irons opposite each duct bank entrance.

G. Access to deep manholes shall be through a chimney. Permanent ladders or rungs shall be installed, if required by the Engineer on site or shown on the Drawings.

H. Manholes shall be provided with earth-rods and cable supports as per the requirements of Local Standards Organization, BS or Electricity supply Authority.

I. The frames and covers of all manholes shall be heavy duty, cast iron, round with solid type gasket lids, and countersunk locking devices. Covers shall seal tightly and not rock, when installed.

2.05 HANDHOLES

A. Handholes may be formed either monolithically or built up to designed sizes by combining several concrete sections cast in various shapes and sizes.

B. Handholes shall be provided with cast iron covers, sumps, ground-rods, etc. as shown on drawings or required as per the requirements of Local Standards Organization, BS or other applicable standards. Section joints shall be grouted.

C. The frames and covers of all hand holes shall be heavy duty, cast iron, round with solid type gasket lids, and countersunk locking devices. Covers shall seal tightly and not rock, when installed.

2.06 EARTH ROD PITS

A. Earth rods pits shall be provided for all earth rods in accordance with the requirements of Section 16640.

B. Earth rod pits shall be precast of either square or round section with cover.

C. The cover of earth rod pits shall have appropriate marking as approved by the site Engineer.

2.07 CONCRETE PADS

A. Concrete pads shall be provided for all pad mounted equipment.

B. Concrete pads shall be 150 mm high, unless otherwise indicated, complete with steel reinforcement and necessary bolts, anchors, etc. required for the proper installation of pad mounted equipment.

C. Structural calculations for concrete pads supporting heavy equipment shall be submitted for Engineer's approval before commencement of work on site.

2.08 CABLE WARNING SIGNS AND TAPES

A. Where cables are directly buried, cable warning signs shall be installed to minimize the likelihood of damage to the cables by excavation. These signs shall be suitable for mounting on a riser pole, substation fence or separate stakes to suit the installations.

B. Posts for cable warning signs shall be placed as close to the cable as practical, but not closer than 900 mm horizontally from the cable.

C. Cable warning tapes shall be provided in accordance with the requirements given in Section 16120. Tapes shall be placed at least 300 mm above the buried cables, and shall cover full width of the cable trench.

PART 3 EXECUTIONS

3.01 INSPECTION

A. Establish and propose exact routes and requirements of underground electrical services for approval of the Engineer, after co-ordination with all other existing or new underground services, before commencement of the work on site.

B. Examine the areas and conditions under which the underground electrical services are to be installed, and correct any unsatisfactory conditions detrimental to the proper and timely completion of the work. The Contractor shall not proceed with the work until all unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02 EXCAVATION AND BACKFILLING

A. Before commencement of the excavation, check the presence of any existing underground service by means of appropriate tools and equipment. The Contractor shall be penalized for damaging of any existing services in accordance with the rules and regulations set forth by the Owner and described in Section 16050.

B. Carry out excavation and backfilling in accordance with the requirements of Section 02221.

3.03 DUCT BANKS INSTALLATION

A. The direct buried PVC ducts shall have a minimum dry sand cushion of 150 mm and a minimum dry sand cover of 300 mm, over which 50 mm thick concrete tiles shall be placed.

B. Depth for direct buried PVC ducts and PVC coated rigid steel conduits shall not be less than 600 mm from finished grade level to the top of conduits.

C. Top of concrete encased duct banks shall be installed 600 mm minimum below finished grade and shall connect manholes and handholes as shown and required on site. Where a duct bank connects to a building, adapt the duct bank, at one meter beyond the building exterior wall, to the building conduit with the required couplings.

D. The concrete encasement surrounding the duct bank shall be rectangular in cross-section, having a minimum concrete thickness of 75 mm beyond any surface of the conduit. Interlocking spacers shall be used to secure a uniform spacing between conduits of not less than 75 mm.

E. Trenches and duct banks shall be graded so that conduits will have a fall of at least 75 mm per 30 m towards the lower manholes or from the high point of the section towards the manholes or from the building towards a manhole.

F. Changes in direction of duct bank runs shall be accomplished by using special couplings limited to 5 degrees and/or 45 degrees bends having a 1 m radius sweep with straight sections of ducts between changes of direction and `S' sweep sections having a minimum of 500 m offset.

G. Where duct bank enters manholes, conduits shall terminate in end bells. Clean each conduit thoroughly before laying. During construction and after completion of the duct banks, plug the ends of conduits to prevent water washing mud into the conduits. Take particular care to keep the conduits clean of concrete or any other substance during the course of construction.

H. Securely anchor duct and brace with intermediate and base plastic spacers to prevent movement during the placement of concrete.

K. After the completion of portion of duct bank, a mandrel not less than 300 mm long, with a diameter of approximately 6 mm less than the inside nominal diameter of the conduits shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through to make certain that no particles of earth, sand or gravel have been left in the line. This cleaning shall be done one day after the concrete has been poured.

L. Install a nylon rope in each conduit after cleaning, after which the conduits shall be capped/plugged immediately.

M. All duct banks shall enter manholes through rectangular openings of suitable dimensions provided in walls. Such holes shall be sized to properly receive the duct, but shall not be too large for proper caulking. The space between duct banks and manhole walls shall be caulked tight with lead wool.

3.04 STUB-UPS INSTALLATION

A. Comply with relevant requirement of Section 16130.

B. Exact stub-ups locations and termination requirements for each equipment shall be verified on site, before commencement of laying underground or underfloor PVC conduits for required power and control wiring.

C. Where extensions of PVC conduits above grade are required as stub-ups, a transition bend having PVC/Steel coupling on one end and threaded male or female adapter on the other end shall be used.

D. The PVC coated rigid steel transition bend or conduit shall extend minimum 150 mm above grade. A concrete envelope 100 mm high above the finished floor shall be formed around such risers to minimize corrosion at point of emergence. The top of the envelope shall be sloped for drainage.

3.05 CONSTRUCTION OF MANHOLES AND HANDHOLES

A. Manholes and handholes shall be constructed of precast or cast-in situ concrete to sizes shown on the Drawings. Horizontal concrete surfaces of floors shall have a smooth steel trowel finish.

B. Frames and covers shall be watertight and covers shall fit the frames without undue play. These shall be free from warp and blow holes that may impair their strength of appearance.

C. Steel and iron shall be formed to shape and size with sharp lines and angle and shall have a smooth finish.

D. Provide all necessary lugs and brackets.

E. Set pulling-in irons and other built-in items in place before pouring concrete.

F. Provide a 3 m earth rod external to each manhole and handhole. Also provide an earth bar in each manhole and handhole affixed to the wall above the duct bank box-outs. Connect to earth rod using 70 mm^2 bare copper conductor and bond earth conductors associated with each power cable inside the manhole or handhole.

3.06 CABLE WARNING SIGNS AND TAPES INSTALLATION

A. Direct buried cables shall be installed in accordance with the requirements for external cable installation given in Section 16120.

B. Cable warning signs shall mark all direct buried splices and shall be placed at intervals not exceeding 30 m along the cable route.

C. Cable warning tapes shall be installed 300 mm directly above cable throughout the entire cable route and shall cover the full width of cable trench.

END OF SECTION

SECTION – 16140
WIRING DEVICES AND DISCONNECTING SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wiring Devices used as accessories for the Electrical Installations including, but not limited to the following:-

1. Indoor lighting switches.
2. Outdoor lighting switches.
3. Door and ceiling switches.
4. 13A switch socket outlets.
5. Industrial socket outlets.
6. Isolators and switch fuse units.
7. Spur or fused connection units.
8. Fused clock connectors.
9. Outlets for low current systems.
10. Explosion - proof wiring devices.

1.02 RELATED SECTIONS

A.	Section 16050	Electrical Works, General.
B.	Section 16075	Electrical Identification.
C.	Section 16130	Electrical Raceways and Boxes / Fittings.
D.	Section 16070	Equipment Connections and Supports.
E.	Section 16420	LV Protective Devices.

1.03 REFERENCES

A. B.S3676 Part 1: 1989 & EN 60669-1

B. BS EN 60529:1992

C. B.S1363: Part 2-1995

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating to the wiring devices proposed, which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Name and address of agents stating whether any manufacturing or fabrication is carried out in the Jordan.
4. Technical performance of the equipment selected.
5. Dimensional details needed for installation and maintenance.
6. Delivery time from the date of orders.
7. Copies of test reports or certificates.

B. Provide samples of proposed wiring devices together with the above submittal for approval of the Engineer.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of wiring devices of types and ratings required, and whose products have been in satisfactory use in similar service for not less than 5 years. Preference shall be given to local manufacturers and agents/suppliers.

B. Wiring devices shall comply with the applicable standards of Local Standards Organization and BS.

C. Any defects or damage caused partly or wholly in the installation of wiring devices to the building or building fabric shall be made good to the satisfaction of the Engineer.

1.06 DELIVERY, STORAGE AND HANDLING

A. All wiring devices shall be delivered in factory pack wrapping and boxes and stored in a clean, dry space within the racks.

1.07 SPARE PARTS

A. Unless otherwise specified, supply as maintenance stock, additional wiring devices of each type and rating installed on site, amounting to one unit for every 10 installed units, but not less than 2 units of each type and rating. These shall include all types of wiring devices described herein.

1.08 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 PRODUCTS

2.02 GENERAL

A. Lighting switches shall conform to B.S 3676 Part 1: 1989 & EN 60669-1.

B. For single and multi-gang units in locations where installation work is on the surface, light switches shall be metal clad type

C. For single and multi-gang units in general locations where installation work is concealed, light switches shall be of the "MK logic type" and metal clad for surface installations

D. Switch plates, socket-outlet plates and similar items shall be of white plastic type for recessed installations and to the approval of the Engineer.

E. Decorative finishes of metal plates shall comply with appropriate standards, as mentioned elsewhere. The finish and/or color shall be standard throughout the installation unless otherwise indicated or as directed by the Engineer.

F. Switches shall comply with reference standards and be suitable for use on inductive and resistive loads. They shall be single pole for 1-phase and neutral supply and double pole for 2-phase supply, unless otherwise indicated or directed by the Engineer. Where switches are mounted adjacent one to another, they shall be grouped in a single enclosure and share a common switchplate.

G. Where indicated, switches with pilot lamps shall be provided. This lamp shall be a 6 Watt neon lamp with resistor and red colored lens unless otherwise indicated.

H. Plugs from the same manufacturer as that of the socket outlets shall be provided with all types of socket-outlets, and handed over to the Engineer.

I. All the materials used in the manufacture and installation of disconnect switches, push button stations, isolators and mains power isolation shall be of high quality and of proven suitability for the functions they will perform and the conditions they will meet in service. Each of these items shall be the product, manufacture and assembly of one manufacturer only.

J. For remote monitoring/controls, comply with the requirements as given in Section 15180.

2.03 INDOOR LIGHTING SWITCHES

A. Lighting switches shall conform to B.S3676 Part 1: 1989 & EN 60669-1.

B. Lighting switches for interior use, shall be heavy duty, AC, single or double pole, minimum 10A with number of ways as shown on the Drawings and mounted on adjustable grid enclosed in metal box. The switches shall be of the quick make, slow break type and shall be capable of switching 100 % rated load of the types shown on the Drawings.

C. Where switches are to be flush type they shall be supplied with overlapping cover plates finished flush with the sides of the metal box.

2.04 OUTDOOR LIGHTING SWITCHES

A. All outdoor lighting switches shall have the characteristics as described above for indoor lighting switches, but be complete with a gasket forming splash proof and dustproof enclosures.

B. Waterproof switches and enclosure shall comply with BS 3676: Part 1:1989 and protected to IP56 according to BS EN 60529:1992, construction of enclosures shall be from extremely robust polycarbonate sailed against dust & water & impact resistant

C. A suitable drain hole shall be provided.

2.05 DOOR AND CEILING SWITCHES

A. The door and ceiling switches shall comply with BS and other applicable standards and suitable for the intended application on site.

B. The door switches shall be plunger operated, rated for a minimum of 3 Amperes at 230 volts and suitable for mounting on all types of wooden and metal doors of the project.

C. Each door switch shall have both normally close and normally open switch contacts which shall give facilities to open or close the supply circuit whenever door is opened. Appropriate switch contact shall be used according to the site requirements and intended application.

D. The door switches shall be furnished complete with the back box and front plate, suitable to be mounted on the required doors. The finish of the front plate shall match with the finish of other door hardware or as directed by the Engineer.

E. The ceiling switches shall be single pole or double pole, one way or two way, rated 6 amperes or more at 230 Volts, as required for the intended application and as directed by the Engineer.

F. The ceiling switches shall operate on pull to make or pull to break principle, in accordance with the site requirements. These shall be provided with a minimum of 1500 mm long nylon switch/pull card to operate the switch. The length of pull cord shall be made suitable for the accessibility of users in all situations of operations. .

2.06 Ampere switch socket outlets

A. 13 Amperes, 230 Volts, switch socket outlets shall be provided for the connection of portable electrical appliances throughout the Project. They shall be switched, flat pin pattern to B.S1363: Part 2-1995, accepting 3 pin fused plugs.

B. Generally socket outlet face plate shall be finished in white similar to the lighting switches.

C. Socket outlets shall be mounted in flush metal box. Where surface mounted socket outlets are required, they shall be similar to that of the flush pattern, mounted on suitable adapter boxes.

D. Socket outlets provided in services plant rooms shall be metal clad type, surface or flush mounted as indicated elsewhere.

E. Weatherproof socket outlets shall be provided with push-on cap retaining ring without switch.

F. All surface mounted socket outlets shall be provided with a 13 A unbreakable plug top complete with fuse. Each twin socket shall be counted as two socket outlets.

2.06 INDUSTRIAL SOCKET OUTLETS

A. Industrial socket outlets shall be single or multi-phase, of the types and ratings as indicated on the Drawings and schedules.

B. Socket outlets shall have an enclosure of IP44 or IP67, integrated with switch or without it, as shown on the Drawings and required on site.

C. Single phase socket outlets shall be with two poles and grounding pin and three phase socket outlets shall be with three poles and grounding pin, with or without neutral pin, as shown on the Drawings and required on site.

D. The industrial socket outlets shall be designed so that the grounding pole is permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged, when the plug is inserted into the socket.

E. The plug sleeve shall also make contact with the housing of socket outlet, before the line and load poles make contact.

F. The industrial socket outlets shall include cast back box, angle adapter, gaskets and a screw type gasketed watertight cap with chain fastener.

G. Each industrial socket outlet shall be provided with plug from the same manufacturer as that of the socket outlet.

2.07 ISOLATORS AND SWITCH FUSE UNITS

A. The isolators and switch fuse units for small power applications shall be of the double pole or three pole, single throw type, complying with the requirements of BS and other standards mentioned elsewhere in the Specifications.

B. Finishes of all isolators and switch fuse units shall be either of white plastic for flush mounted installations or rust proof metal for surface mounted installations or as directed by the Engineer on site.

C. These wiring devices shall be used for the isolation of single phase, two phase and three phase items of fixed equipment fed by an individual circuit.

D. Types of equipment fed through these wiring devices are described elsewhere in the Specification and on the Drawings.

E. All fuses in the switch fuse units shall be of HRC type, as described in Section 16420.

2.08 SPUR OR FUSED CONNECTION UNITS

A. Spur or fused connection units shall be one complete unit combining a double pole switch, and a pilot light for confirmation that the unit is turned on.

B. The current and voltage rating of the spur or fused connection units shall be in accordance with the power requirements of the equipment to be fed.

C. All surface mounted spur units, with the exception of those to be installed in services and plant

rooms, shall be mounted on metal or plastic purpose-made mounting boxes of the same material as that of the front plates.

D. In plant rooms and services rooms, spur units shall be of the surface mounted type and shall be metal clad.

2.09 FUSED CLOCK CONNECTORS

A. Fused clock connections shall comprise a socket with fused plug. The plug shall be secured to the socket by means of a screw. The connector shall be mounted on a metal box set flush into the wall.

B. The front plate of the fused clock connector shall have same finish as that of other wiring devices.

C. The fused plug shall be fitted with 3 A cartridge fuse link on one pole and shall have facilities for grounding the metal work of the clock.

2.10 OUTLETS for low current systems

A. The outlets for all low current systems such as telephone, data, television, etc. shall conform to the requirements given in respective sections of low current systems contained elsewhere in these Specifications.

B. The cover or face plates of the outlets for all low current systems shall be of similar style and finish to that specified for the associated lighting switches and socket outlets and shall be suitable for mounting recessed or surface as required on site.

C. Unless otherwise specified, telephone and data outlet plates shall be complete with a terminal box suitable for termination of 2 or 4 pair cable as minimum and a cable clamp to secure the outgoing telephone handset connecting cable.

D. Unless otherwise specified, TV outlet plates shall be complete with one co-axial socket outlet. Where twin outlets are required to provide both FM/Radio and TV signals, they shall be complete with duplexing network as necessary.

2.11 EXPLOSION PROOF WIRING DEVICES

A. Explosion proof wiring devices shall conform to BS and shall comply with the hazardous classifications of the area, as applicable for special occupancies.

2.12 CEILING ROSE

Ceiling roses shall be of approved manufacture and finished as switches confirming to BS 67:1987 and BS 4568 Part 2. Ceiling roses shall be of the plug in type with 4 terminals (L, N, Loop-In & E). Ceiling rose shall be of the funnel shaped cable entry. Heat resistant PVC insulated and sheathed flexible cable shall be provided to BS 6141:1981.

2.13 HAND DRYER

Hand Dryers shall be fully automatic type, including all accessories needed. Auto pilot hand dryers feature convenient hands-free operation, an electronic sensor automatically turns dryer on when hands are placed under the nozzle. Auto pilot turns the dryer off when user removes hands. The dryer will not stop until user is satisfied that hands are dry as the dryer is operating only as user need it, an auto pilot save operating and energy costs. Dryer shall be surface mounted type. Cover features concealed air intake grille, stainless steel cover 230V, 50Hz, 2.0kW 38 L/S air flow. Noise level should be less than 65 dB.

2.14 disconnect SWITCHES

A. Disconnect Switches shall be UL listed, surface mounted, general or heavy duty type, sheet steel enclosed of the types, sizes and electrical characteristics suitable for the intended applications of motor, circuit or equipment disconnections as shown on the Drawings, Schedules and elsewhere in the Specifications.

B. The general duty type disconnect switches shall be rated for 230/400 Volts, 50 Hertz with 2/3 - blades, 2/3 poles, incorporating spring assisted, quick-make, quick-break type switches which are so constructed that switch blades are visible in OFF position with door open.

C. The heavy duty type disconnect or safety switches shall be fusible type, rated 500 Volts, 50 Hertz, 3-blades, 4-poles, solid neutral, incorporating spring assisted quick-make, quick break type switches which are so constructed that switch blades are visible in OFF position. These shall have positive pressure type reinforced fuse clips.

D. Equip with operating handle which shall be an integral part of enclosure base and whose position is easily recognizable, and is capable of being padlocked in OFF position.

E. Current carrying parts of all types of disconnect switches shall be constructed using high-conductivity copper, with silver-tungsten type switch contacts and stamped enclosure knockouts.

F. HRC fuses for heavy duty safety switches shall be of the classes, types and ratings needed to fulfill electrical requirements for services indicated and as recommended by the manufacturer. The fuses shall be in accordance with the requirements given in Section 16420.

G. All outdoor disconnect switches shall be weatherproof, stainless steel enclosures suitable for wet and damp locations, and rust and dust-proof. These shall have appropriate heat resistant gasket to provide protection against dust and water.

2.15 ISOLATORS AND SWITCH FUSE UNITS

A. The isolators and switch fuse units for small power applications shall be either of white plastic or rust proof metal.

2.16 PUSH BUTTON STATIONS

A. All push buttons shall be made of non-hygroscopic materials, non-swelling and fitted to avoid any possibility of sticking. Non-retaining type shall generally be used except for emergency stop push buttons which shall stay down when operated and be fitted with mushroom type heads.

B. Contacts of all push buttons shall be strong and have a positive wiping action when operated.

C. All push button stations shall be provided with labels.

D. All push button stations in plant rooms, outdoor or wet locations shall be within weatherproof enclosure with appropriate heat and weather resistant gasket.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which wiring devices are to be installed and correct any unsatisfactory conditions detrimental to proper and timely completion of the Work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

B. Coordinate the exact location and mounting heights of all wiring devices with architectural, interior design and plant / equipment layouts, location of doors, loose and fixed furniture, equipment and accessories, other services, piping, etc. Any discrepancy between electrical drawings and other

disciplines/details shall be brought to the attention of Engineer.

3.02 INSTALLATION OF WIRING DEVICES

A. Install wiring devices where indicated, in accordance with manufacturer's written instructions, applicable requirements of Local Standards Organization, IEE Wiring Regulations and in accordance with recognised industry practices to ensure that products serve their intended function.

B. Program installation of devices after wiring is completed and tested for satisfactory insulation resistance.

C. Install devices only in electrical boxes which are clean and free from any external building materials, debris, etc.

D. In walls or ceilings of concrete, tile or other non-combustible material, boxes and fittings install boxes and fittings so that the front edge of the box or fitting will not be set back from the finished surface more than 5 mm. In walls and ceilings constructed of wood or other combustible material, outlet boxes and fittings shall be flush with the finished surface or project there from.

E. Plaster surfaces around the back boxes of the wiring devices that are broken or incomplete, shall be repaired so that there will be no gaps or open spaces at the edge of the box or fittings.

F. In making an exposed surface extension from an existing outlet of concealed wiring, a box or an extension ring shall be mounted over the original box and electrically & mechanically secured to it.

G. All wiring devices shall be fixed independently of the system of wiring. All fixing screws or bolts shall be of steel and where the appropriate apparatus has a protective coating of zinc or is mounted outside, an electro-galvanized finish shall be used complying with relevant standards and codes of practice.

3.03 FIELD QUALITY CONTROL

A. Check operation of all switches and wiring devices with power supply connected.

B. Check polarity of all the outlets and receptacles with polarity tester.

END OF SECTION

SECTION – 16150
WIRING CONNECTIONS

PART 1 GENERAL

1.1 SCOPE

A. The Contractor shall provide the power cabling, terminations and containment from mechanical control panels to all mechanical items of equipment, Low voltage cabling. The electrical contractor shall refer to the BMS schematics and mechanical services layout drawings to determine the extent of conduit required for both power and BMS cabling. BMS cabling shall in included under BMS specification requirements in the mechanical specifications division.

B. The contractor shall ensure that no wiring commences on site without fully approved medical, mechanical, kitchen, laundry, BMS, electrical equipments .. .etc schematics and layout drawings.

C. The Contractor shall include final connection wiring and terminations between interface units installed by the Contractor (eg fire alarm interface units) and the piece of equipment served by that interface unit (eg fire damper).The contractor shall allow for I/O units for each item of equipment and control panel.

D. The Contractor shall include final connection wiring and terminations between interface units installed by the Contractor (eg fire alarm interface units) and the piece of equipment served by that interface unit (eg sprinkler flow switch).

1.02 REFERENCES

A. BS 6004 - Specification for PVC Insulated Cables (non-armoured)

B. BS 6121 - Mechanical Cable Glands (Specifications for).

C. BS 6500 - Specification for Insulated Flexible Cords and Cables.

D. BS 6746 - Specification for PVC Insulation and Sheath of Electric Cables.

E. BS 7671 - Requirements for Electrical Installations (IEE Wiring Regulations, 17th Edition).

1.03 RELATED SECTIONS

A. Section 16050 - Electrical Works, General.

B. Section 16075 - Electrical Identification.

C. Section 16120 - LV Cables and Wires.

D. Section 16070 - Equipment Connections and Supports.

E. Section 16134 - Underground Electrical Services.

F. Section 16150 - Wiring Devices.

G. Section 16910 - Testing and Commissioning

1.04 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of raceways of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall be given to local manufacturers and agents/suppliers.

B. Installer: Firms regularly engaged and qualified with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.

C. Wiring connections shall generally be manufacturer's standard construction and materials. Where this contradicts any part of the Specifications, the Contractor shall state so at the time of tender.

D. All wring connections and accessories furnished under these Specifications shall conform to the applicable standards of Local Standards Organization, IEE, IEC and BS.

1.05 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

- Name of the manufacturer.
- Country of origin.
- Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.
- Technical performance of the equipment selected.
- Dimensional details needed for installation and maintenance.
- Copies of test reports or certificates.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Store Pack all wiring accessories for protection during transportation.

B. Store wiring connections in an appropriate protection against corrosion and damage.

C. Do not install wiring connections and accessories until it can be protected from damage during construction.

1.08 COORDINATION

A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.

B. Determine connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation of equipment.

D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 CABLE TYPES

A. Cables shall be utilized as detailed in Section 16120.

2.02 LOW VOLTAGE CABLE AND WIRING (SUPPORT SYSTEMS)

A. Support all cables and wiring throughout their length as detailed in sections 16120, 16130 and 16070.

2.03 WIRING

A. Wiring cables shall be utilized as detailed in section 16120, 16140, 16225 and 16443.

2.04 CONNECTIONS

A. Each equipment connection shall be provided with complete assembly of materials, including but not necessary limited to, pressure connectors, terminals, lugs, electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices and terminations of wires and cables.

B. Heavy gauge PVC and metal conduits, tubing and fittings of the required types, grades, sizes and thickness, for each type of electrical equipment connection shall be provided. Where types and grades are not indicated, provide proper selection to comply with wiring and raceway requirements. Provide products complying with section 16140 and in accordance with the following listing of conduit, tubing and fittings.

- Heavy gauge PVC conduit and fittings (for indoor except plant rooms).
- PVC coated rigid steel conduit and fittings (for outdoor, wet areas and plant rooms).
- Rigid steel metal conduit and fittings.
- Electrical metallic tubing and fittings.
- PVC coated electrical metallic tubing and fittings.
- Flexible metal conduit and fittings (for indoor except plant rooms and wet areas).
- Liquid-tight flexible metal conduit and fittings (for outdoor, wet areas and plant rooms).

C. Electrical connectors, lugs and terminals for the wires and cables shall be provided as recommended by the connector and terminal manufacturer for intended applications.

D. Equipment connection accessories such as electrical insulating tape, heat-shrinkable insulating tubing and boots, solder, electrical soldering flux, wire nuts, cable ties, etc. shall be provided as recommended by accessories manufacturers for the intended applications and as approved by the Engineer.

E. For remote monitoring/controls of the electrical connections to various equipment, comply with the requirements of division 22.

PART 3 EXECUTION

3.01 GENERAL

- All clauses as detailed in section 16120, 16140 and 16443.

3.02 EXAMINATION

- Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.03 INSTALLATION

A. Make electrical connections.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.

D. Install receptacle outlet to accommodate connection with attachment plug.

E. Install cord and cap for field-supplied attachment plug.

F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

H. Install terminal block jumpers to complete equipment wiring requirements.

I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.04 ADJUSTING

A. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations.

B. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION

SECTION – 16410
LV POWER DISTRIBUTION BOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES THE FOLLOWING FOR LOW VOLTAGE (LV) DISTRIBUTION

A. Main Distribution Boards

B. Factory assembled main or sub-main LV Power Distribution Boards and accessories.

1.02 RELATED SECTIONS

A. Section 16050 Electrical Works, General.

B. Section 16075 Electrical Identification.

C. Section 16150 Wiring Devices and Disconnect Switches.

D. Section 16423 Enclosed Starters and Contactors.

E. Section 16420 LV Protective Devices.

F. Section 16910 Electrical Testing and Commissioning.

1.03 REFERENCES

A. BS 7671- Requirements for electrical installations: IET Wiring Regulations - Latest edition

B. IEC/EN/BSEN 60947-1 & 2 - Low Voltage Switch gear and Control Gear; General Rules and Circuit Breakers - Latest edition.

C. EN / IEC 60898 - Circuit breakers for overcurrent protection for household and similar installations.

D. IEC 60664-1 - Insulation coordination for equipment within low-voltage systems; Latest edition.

E. IEC 61000-4-1 - Electromagnetic compatibility; Latest edition.

F. IEC/EN/BSEN 61439-1 & 2 - Low-voltage Switchgear and Control gear assemblies; Latest edition.

G. IEC 61557-12 - Performance measuring and monitoring devices (PMD); Latest edition.

H. IEC 60068-2 -Environmental testing; Latest edition.

I. Guide to Forms of Separation – BSEN 61439-2 (BEAMA) Low Voltage Switchgear and Control gear assemblies.

J. IEEE 519 – Recommended Practices and Requirements for Harmonic Control of Electrical Power Systems.

K. IEC 60269 – Low voltage fuses.

L. IEC 60529 – Degrees of protection provided by enclosures (IP Code)

M. IEC/TR 61641 – Guide for testing under conditions of arcing due to internal faults.

N. IEC 60909 – Short-circuit currents in 3 phase AC systems calculations.

O. Relevant IEC standard for all other products when not specifically stated.

P. Local Authority Requirements and Regulations.

1.04 SUBMITTALS

A. Contractor shall be responsible for carrying out the Voltage drops, Harmonics, Short circuit and Earth fault current calculations, Protective discrimination and Reactive power compensation studies for the entire LV distribution system. Detailed reports shall be submitted for approval.

B. A protective device coordination study shall also be carried out to ensure that all protective devices are fully coordinated & discriminated based on specific tripping curves of protective devices proposed and considering specific calculated prospective short-circuit currents at various levels in the distribution network.

C. These studies and calculations shall be based on the actual devices, loads, bus risers and cable lengths installed.

D. The LV schematics shall be prepared on the basis of this study and shall be to the approval of the MEPD Engineer.

E. Product Data: Provide manufacturer's standard catalogue pages and data sheets for switchboards, enclosures, overcurrent/earth fault protective devices, and other installed components and accessories.
   Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

F. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   a. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
   b. Include wiring diagrams showing all factory and field connections.
   c. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   d. Include documentation of listed breaker frame/trip ratings upon request.
   e. Include documentation demonstrating protective coordination upon request.

G. Workshop drawings final Distribution Boards shall be submitted to the MEPD Engineer for approval and shall indicate the following:
   a. General arrangement drawing.
   b. Bill of Materials.
   c. Protective device types, characteristics and ratings.
   d. Dimensioned drawing.
   e. Cable entry details.
   f. Schedule of labels.

H. As-Built (record) Drawings: Submit hard and soft copies. Carry out specified routine & field tests and submit test sheets after taking approvals on the testing formats.

I. Source Quality Control Test Reports: Include reports for tests designated in IEC 61439 as production (routine) tests.

J. Field Quality Control Test Reports.

K. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals. Manufacturer’s written instructions for testing and setting overcurrent protective devices. Time-current curves for each type of protective devices.

L. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   a. Enclosure Keys: Two of each different key.
   b. See Section 26 2813 for requirements for spare parts, fuses and spare fuse cabinets.

M. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:
   1. Name of the manufacturer.
   2. Country of origin.
   3. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.
   4. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
   5. Technical performance of the equipment selected.
   6. Dimensional details needed for installation and maintenance.
   7. Copies of test reports or certificates.
   8. Control schematics and wiring diagrams.

N. Details of each main and sub-main LV Power Distribution Boards/switchboard including the following:

   1. All components.
   2. Fuse, circuit-breaker and switch ratings.
   3. Current and voltage transformer ratios, class, terminal markings and output.
   4. Instruments, including scale details.
   5. Relay types and characteristics.
   6. Indicating lamps, including color.
   7. Position of switches, and details of function.
   8. All internal connections, with terminal markings.
   9. Arrangement of terminal blocks.
   10. Wire numbers.
   11. Size, type and color of secondary wiring.
   12. Principal physical dimensions, including clearances required for removing covers, opening doors, operating handles, withdrawing equipment, etc.
   13. Position of all panel face equipment.
   14. Identification of all equipment, and appropriate label inscriptions.
   15. Foundation details, including weights and fixing points.
   16. Cable entry details including gland and gland plate provisions.
   17. E. Submit list of tools, test equipment, spare parts and ancillary equipment.
   18. F. Submit the factory test reports verifying that the LV Power Distribution Boards have successfully passed all routine tests. Type tests results shall be submitted, when required by the Engineer.

1.05 QUALITY ASSURANCE

A. Conform to the requirements of relevant IEC/EN and BSEN standards.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Appointment of Specialist Contractor
   1. The contractor shall hand over to the MEPD Engineer a complete photographic record of the survey. Switchgear manufacturer shall ensure to coordinate and offer all assistance to the specialist contractor in this regard.
   2. If the load available at the time of handover is not sufficient enough for the infrared testing, then the same shall be done during the defects liability period in coordination with the Client and the MEPD Engineer.

D. Manufacturer Qualification: A firm regularly engaged in the manufacture of LV Switchboards of types, sizes and capacities required and whose products & equipment's have been in satisfactory use in similar service for not less than five years.

E. Installer qualification: Engage an experienced installer with minimum five years of successful installation experience on projects utilizing LV distribution board units similar to those required for this project.

F. Comply with applicable local regulations/codes/requirements of authorities having jurisdiction.

G. Complete design verification certification of proposed DBs to IEC/EN 61439-1&2 and IEC/TR 61641 (where applicable) shall be provided which has been issued by an internationally accredited independent certifying body such as ASTA, DEKRA etc. Accreditation of the certifying body as well as the testing laboratories shall be submitted for approval.

F. The distribution boards shall comply with the requirements of BS, IEC and Local Standards Organization.

1.06 DELIVERY, STORAGE AND HANDLING

A. Handle Panel boards and enclosures carefully to prevent breakage, denting or scoring the finish.
B. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions.
C. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
D. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover/wrappings to protect units from dirt, water, construction debris, and traffic.
E. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.
F. Inspect equipment to ensure that no damage has occurred during shipment.

1.07 SPARE PARTS

A. Unless otherwise specified, supply as maintenance stock, additional circuit breakers, fuses, lamps and other components of LV power distribution boards, amounting to one unit for every 10 units, but not less than 2 units of each type and rating.

1.08 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions or 1 year from the date of the substantial completion of the project
B. Provide complete system warranty in which the Manufacturer and Contractor are jointly and severally liable and agree to repair/replace all defective components of the warranted system. Warranty shall include both material s and workmanship.

PART 2 PRODUCTS

2.01 GENERAL

1. All materials specified herein shall be of high quality and of proven suitability for the functions they will perform and the conditions they will meet in service.
2. Products other than specified under basis of design are subject to compliance with project requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.
3. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and all obtained from a single supplier.
4. All LV Switchgear and main power distribution boards shall be IP55 rated for outdoor/Workshops & IP 42 for indoor use form 4b type 6 for all ratings above or equal to 1000A and form 2b for lower than or equal to 800A canopy for direct sun and rain to be considered. To cover at least minimum 100mm of top part from lateral and back side extended at least 200mm from front side

5. All outgoing feeders MCCB's MCB's and control/metering equipment on boards shall be clearly labelled by means of engraved traffolyte labels to indicate the function of all equipment, and sub boards and circuits fed from each feeder MCB.
6. The distribution boards shall be supplied complete with adequately sized good quality plastic pouch for insertion of approved load schedule. The arrangement shall be to MEPD Engineer's approval.
7. Each ACB, MCCB or MCB module shall be numbered consecutively with engraved trifoliate labels. refer respective section for LV switchgear specifications and MCB & ELCB specifications.
8. Each LVSG our MPB shall be provided with an engraved label indicating designation and size plus origin of feeder cable plus earth wire.
9. All System Bus-Bars (Mian -Dropper - Feeders connections outgoing connectors,comb bus bars / pan-assembly busbars shall be made of high quality high purity not less than 99.95 electrolytic copper busbars, high conductivity hard-drawn copper for dry locations and same hard-drawn tinned copper for areas where wet conditions and/or high humidity is expected , covered and sleeved with heat shrinkable PVC of not less than 1000V insulations specially for tined copper) whenever its applicable tinned copper. Design verified system and copper bus-bar drawings recommended by Manufacturer to be used which are certified by ASTA/DEKRA or equivalent independent certifying bodies in full compliance with IEC/EN 61439-3 assembly standard. Certificates shall be provided to ensure compliance. LVSG and Main power panels shall be tested and certified for a short-time withstand rating Icw of not less than Icu=Ics=50KA for 1 seconds as per IEC 61439-3.

a. All breakers, ACB's, MCCBs, MCB's and protection devices and control components are to be clearly labelled, providing a clear and permanent indication of the circuit reference and the plant protected. Each group of MCB's shall be installed in the enclosure for ease of identification and fault finding wherever applicable.
b. Neutral and earth bars shall be of adequate capacity for present and future circuits (one conductor per terminal) and shall be terminated using proper ferrule/lug.
c. All contactors specified shall be rated for AC-3 duty, with 230V continuously rated coils.
d. Incoming cable shall be terminated directly to the incoming isolator. Ensure to coordinate cable entries and locate incomer isolator accordingly as incoming cable will not be allowed to reticulate within the distribution board. Incoming and outgoing wires shall always be reticulated separately and shall not cross.
e. MCBs used in the final distribution boards shall have rated breaking capacity Icn of 10kA as per IEC 60898.
f. All components shall be suitable for continuous operation at the specified ambient temperature.
g. All time switches specified shall be of the quartz type for 24/7 operation with minimum 50-hour rechargeable battery reserve. Astronomy timers can be preferably used with same reserve time
h. Rated operational voltage Ue of the distribution board shall be 415 volts, 3phase, 50Hz.
i. Rated insulation voltage Ui shall not be less than 690 volts and the rated impulse withstand voltage Uimp shall not be less than 8kV.
j. Incoming terminals of main incomer switches shall be effectively shrouded to prevent inadvertent contact with live terminals, when the switch is in the "off" position.
k. All live parts shall be effectively shrouded.
l. All materials used in the manufacture and installation of the LV power distribution boards shall be of high quality and of proven suitability for the functions they will perform and the conditions they will meet in service.
m. For remote monitoring/controls, comply with the requirements as given in Building Management System specifications and requirements.

n. Allow for witness tests to be carried out in factory and give at least 14 days notice before the tests are to be carried out.

2.02 LV POWER DISTRIBUTION BOARDS

1. These specifications are also applicable to the SMDBs, and DBs as relevant.
2. All Main Distribution Boards (MDBs) shall be metal enclosed, multi- cubicle, floor mounted, free standing type with front and rear access with cable entries to suit the approved installation and shall be front & rear aligned. They shall be manually or manually and electrically operated, as shown on the drawings, with matching modular vertical sections to form a continuous integral and rigid structure. All components shall be suitably rated for continuous operation at the specified ambient conditions.
3. Panels shall be designed to allow cable terminations with manufacturer's minimum bending radius especially where restricted height is encountered.
4. Floor mounting switchboards shall be with integral plinths. Switchboard manufacturer shall coordinate with the electrical sub-contractor and ensure to provide appropriate transporting sections for ease of placing the switchboard within the LV rooms.
5. It shall be switchboard manufacturer's responsibility to rejoin all the busbars and complete the gasketing around the sections after the transported sections are placed at the intended location on site.
6. Where located outside and exposed to the weather, switchboards shall be weatherproof type and fully suitable for such location. Rain and sun shade canopies with not less than IP55 or higher to be used
7. All main distribution boards located indoors shall be minimum IP 42 rated. And mounting arrangements shall be to the MEP Engineer’s approval.
8. Where a distribution scheme is not detailed in the required drawings and BOQ, a provisional sum shall be added in the bills of quantities.
9. Electrical switchboards MCCB’s and MCB’s with all protective and control components shall all be from the same manufacturer. Assembler shall be certified Authorized or licensed panel builder partner of the approved manufacturer, with design verification certificates conforming to the relevant IEC/EN/BS 61439-1&2 standards & utility requirements and to the MEP consulting engineer’s approval. Panel builder / assembler shall have a minimum experience of 10 years in the field of switchgear assembly with the same manufacturer under the licensee agreement. The original manufacturer and Authorized/licensed panel builder/ assembler shall have a quality management system conforming to ISO-9001 certified by an approved international certification body. The Manufacturer in cooperation with main Distributors and Authorized or licensed panel builder shall have local stock holding facility, capability of providing after-sales service and shall depute their technical representative within 24hrs to the project site for any emergency service calls.
10. Electrical Switchboards shall conform to the requirements of IEC/ EN / BSEN 61439-1&2 Standards and assemblies shall be design verified by ASTA/DEKRA or equivalent independent certifying bodies. Design verification certificates shall be provided to ensure compliance. Testing laboratories shall be independent, internationally accredited, third party laboratories. Supporting documents in full shall be submitted when requested for.
11. Main distribution boards cubicles shall be of minimum 2mm thick electro- galvanized sheet steel frames and minimum 1.5 mm side and back covers and minimum 2 mm door with electrostatic epoxy powder coated. Approval shall be obtained from the MEPD Engineer for the shade requirement. The paint shade shall be normally RAL 7035. Mechanical impact strength of the enclosure doors & covers shall be IK10 to IEC 62262.
12. All cubicles shall be provided with front hinged doors and rear and side bolted covers/panels and shall have an earth braid/wire connected to the frame. Each functional unit shall have its own compartment with separate door, segregations shall be IP2X, for all MCCB feeders the circuit breaker should be provided with a rotary handle interlocked with the compartment door to prevent opening of the door in the normal duty. Switchboard shall be extendable and designed to allow

other sections to be easily added or removed. Modular cubicles shall have fixed/removable/withdrawable mounting arrangements to meet any power distribution application and as specified in the drawings.

13. It shall be ensured that all live parts are shrouded. Certified rigid metallic partitions shall be used in the switchgear assembly complying with the form of construction specified.
14. Cable alleys/chambers of full height of the panel shall be provided next to the outgoing breakers and with appropriate cable supports and retainers.
15. Appropriate gland plates shall be fitted and it shall also be ensured that the glanding of single core cables shall be on non-ferrous metal plate of minimum 3mm thickness.
16. Main distribution board shall be constructed to Form2b form in full compliance to BSEN / IEC / EN standard.
17. Rated operational voltage Ue of the switchboard shall be 415 volts, 3phase, 50Hz.
18. Rated insulation voltage Ui shall not be less than 690/1000 volts and the rated impulse withstand voltage Uimp shall not be less than 8/12 kV. Test certificates shall be submitted in proof of the same.
19. Main distribution board shall be tested & certified for an Icw rating of 50kA for 3 seconds. The board shall fully comply with the requirements of IEC/TR 61641 for internal arc fault containment tests and successfully tested for Iparc 65kA for tarc 300ms at 415V AC. Test criteria 1-7 or relevant arcing classes for personnel protection & assembly protection shall be successfully verified.
20. The main distribution boards shall comply and perform satisfactorily at the below listed special design conditions as minimum:
    1. Ambient temperature: 40-50ºC (based on climatic condition (dead sea desert /50)
    2. Relative humidity: 90%
21. MDB shall be provided with a metering panel and all necessary equipment and interconnections as may be required by the utility for their tariff/check metering purposes.
22. All CTs shall be accessible and provided with shorting links.
23. Digital energy monitoring unit meters (EMU) shall also be provided for each main switchboard, giving information on phase and line voltages, phase currents, power factor, cumulative kWh, maximum demand, frequency, harmonic distortion, kilo watts etc. and with serial communication interface and pulse output. The EMU shall have a backlit LCD display on the front with buttons for programming and measurement display. Rear panels of EMU shall have fixed terminal block for current and plug-in terminal block for voltage and power supply. Active energy class shall be class 1. Size of the meter shall be minimum 96mm x 96mm.
24. Busbars shall be of high purity and hard drawn copper 99.95 electrolytic copper busbars preferable tinned for wet and high humidity areas but to be covered with shrinkable PVC materials 1000V insulation.
25. Neutral busbar, sleeved tinned copper, rated at full capacity of main busbar shall be distributed throughout the entire length of the switchboard.
26. All copper used for the main busbars shall be electrolytic type hard drawn copper, 99.9 % purity. MIL certificate shall be submitted at the time of FAT to prove the purity of copper busbars proposed. It shall comply with EN13601 Electrolytic Tough Pitch Copper (ETP) and with metallurgical state R250.
27. All busbars shall be 4-pole. Full size neutral busbar shall run continuous through all sections. Earth busbar shall extend full length of the switchboard firmly fixed to the structure of the section in accordance with regulations and standards.

28. Busbars shall be enclosed in a separate compartment and mounted to withstand the required short circuit stresses. Busbar sizes and busbar support distances shall not be different from what has been used in the type tested configurations and type test certificates shall be submitted in proof of the same. Each column shall have its own dropper busbar system rated to the sum of the ampere rating of all MCCB feeders installed within and multiplied by appropriate diversity factor. Sharing dropper busbars for two columns are not allowed.

29. Phase busbars and neutral busbar shall be sleeved and color-coded red, yellow and blue for phases, black for neutral. Busbar chamber (Main and Vertical) shall be provided with covers appropriately labelled.
30. Busbars shall be sized to limit the maximum temperature rise of 90°C above the ambient temperature of 50°C. Type test reports shall be submitted to prove compliance.
31. Control wiring shall be 1.5 mm² minimum cross section, solid drawn or stranded, PVC insulated.
32. All busbar connection links used for ACBs and MCCBs in switchboards shall be of the same cross-section and braced exactly as per type tested configurations. Type Test certificate report sheets shall be submitted in proof for the same. Short-time withstand rating (Icw) of the switchboard shall include incomer ACB, its connection links, main busbars and dropper busbars. Testing shall also be done for the most onerous duty & arrangements and in line with clause 10.10.2.3.7 for temperature rise verification test as specified in IEC/EN 61439-1 standard and at an ambient temperature of 50 deg C.
33. Panel wiring shall be run in PVC wiring ducts with covers, running full length of panel and front accessible. LV wiring and ELV wiring shall be segregated from each other. Control wiring within MDB shall be done with high voltage insulation if no upstream fuses i.e. direct tapping from main busbars are used.
34. All control circuits shall be taken to and made off at a suitable terminal block, properly labelled and with a terminal laminated identification chart nearby.
35. Power circuits shall be taken to and made off at suitable terminals of enough size to handle the current rating of the cable.
36. If the breaker terminals are not suitable for direct termination, extended bus links shall be installed with provision for cable lug termination to the requirement of utility.
37. All wiring shall be neatly run, color coded, properly labelled, ferruled and laced or tied with PVC strip.
38. All wiring shall be tri-rated for 105°C operation.
39. All wire ends shall be terminated with end crimps/ferrule/lugs as appropriate. This is also applicable for the field wiring by the contractor.
40. Sections of panel housing heat producing equipment such as resistances, variable speed drives etc., shall be provided with adequate means for forced ventilation with rodent proof screens.
41. Main distribution boards shall be equipped with combined test class I + II surge protection devices complying with IEC 61643-1 and with surge discharge current rating of Imax 50kA
42. SPDs shall be provided with back-up HRC fuses as recommended by the manufacturer and maintaining minimum length & size of connecting wires.
43. the source of each control circuit shall be protected with a HRC fuse in MDB and ACB Panels mounted directly on the busbars.
44. All breakers of 1600 AF (Ampere Frame) and above shall be of ACB type. All ACBs shall be of withdrawable type. Refer respective ACB specifications under division 16420.
45. All other outgoing breakers in the MDBs, SMDBs and Motor Control Centers shall be of MCCB type. Refer respective MCCB specifications under division 16420.
46. Main Distribution boards shall be tested for seismic protection as per IEC/IEEE/UBC standards with a test certificate from an independent laboratory. Switchboard shall withstand the effects of earthquake vibrations determined according to IEC 60068-3-3, Spectrum AG5 and UBC-Code Zone-4. Certificates shall be submitted proving compliance.
47. Icu=Ics rating of the circuit breakers shall be more than the prospective 3-Phase maximum short-circuit current values calculated at the MDB/SMDB/MCC/DB levels.
48. MCCBs up to 630A shall be current limiting type breakers with standard frame sizes able to

accept different rated trip units.

49. All Circuit Breakers shall have positive contact indication; the breakers shall indicate the TRIP, ON and OFF status by means of the operating toggle.

50. All ACB's shall be suitable for isolation with a 12kV impulse withstand rating and MCCBs shall be suitable for 6/8 kV Uimp. Proposed ACB frame size and type shall be the same as was used in the design verification certification of the proposed switchboard.
51. Earth leakage protection for outgoing feeders if applicable, to meet the short circuit rating of the board shall be by providing earth leakage sensors (ELS) and ACB/MCCB shunt trip wiring.
52. Provide appropriate terminals wired up to suit field wiring by Contractor. Under voltage relay with built in timer to the requirement of utility shall be provided for all relevant HVAC equipment's wherever applicable.
53. All internal and external components of the switch panels shall be labelled with engraved trifoliate labels, black background and 5 mm minimum high white lettering.
54. Labels on the face of panels shall be affixed with rivets, adhesive is strictly not permitted.
55. Provide labels and designations for all terminals and fit plastic tags to all wiring circuits in wiring channels, or where otherwise bunched, to allow easy identification.
56. All labelling shall be repeated on plant wiring diagrams to facilitate reference, particularly in so far as circuit identification and terminals are concerned.
57. The identification and labelling of equipment and conductors shall be in accordance with the relevant BS/IEC/EN standards.
58. All switchboards including SMDBs and DBs shall also be fixed with labels indicating source feeds and load reference.
59. MCCBs used in MDBs shall comply with the requirements of respective specification under division 16420. Outgoing MCCBs shall offer LSI overcurrent protection with electronic trip unit. MCCBs used in MDBs shall be of plug-in type up to 250A and withdrawable type above 400A rating.
60. The incoming section at all the main switch boards shall also be provided with RYB indicating lamps, ammeters (MDI), voltmeters and power factor meters in addition to EMU. Size of the meters shall be 96 sq. mm minimum.
61. MCCB's feeding essential loads (i.e. loads fed from generator supply in case of mains power failure) shall be of plug-in type.
62. Caution labels and labels to indicate future spare usage as required by utility shall also be provided.
63. A mimic diagram shall also be provided on the main distribution board clearly indicating transformer/generator incomers, outgoing feeders and essential sections.
64. Anti-condensation heaters shall be provided in each distribution board cubicles, which must be suitably sized and controlled by a thermostat and humidistat.
65. Anti-condensation heaters are to be enclosed and protected by a separate fuse/circuit breaker in the distribution board with ON/OFF selector switch.
66. When busduct flanges are to be installed in switchboards, tested & certified arrangements shall be followed. Test certificates shall be submitted to prove compliance.
67. If the arc flash assessment result shows a red zone, ACB trip unit protecting this zone shall be provided with an arc reduction option, activated by a limit switch to limit the incident energy during the maintenance of the switchboard, to upgrade to the orange or yellow zone.
68. LV power distribution boards/switchboards shall be designed and constructed to withstand for one second without damage, thermal and mechanical stresses which might arise under short circuit conditions up to the prospective busbar short circuit current. Power distribution boards shall be following IEC 61439-1&2.
69. Switchboards shall be self-contained, free-standing, floor mounting, flush-fronted, multi-cubicle Class 3 or multi-box type as called for on the Drawings and shall be constructed in sections where necessary to facilitate transport and erection.
70. Each switchboard shall be designed for front access and top and bottom entry as shown on the Drawings. Cable terminations and space for terminations shall be suitable for the sizes of cable. All switchboards shall be capable of extension at both ends and busbar chambers shall be fitted with removable end covers.
71. Individual cubicles from which cubicle type switchboards are built shall be rigidly constructed

from folded steel structure frames of 2mm thickness constructing cubical shape ,frames of each cubical or panel shall be firmly welded together for top and bottom sections and welded or bolted to 2m vertical sections of the same type to construct complete cubical, and the required number of cubicles shall be bolted together side by side to construct the required LVSG separate covers for sides and back sides top and bottom or gland plates will be used with minimum 1.5mm however doors of 2mm thick should be used to improve arc flash withstand of doors from front side to protect the operators ,Metal sheet folded type Switchboards constructed from either flat steel plates or flat steel plates on a framework of rolled steel angle shall not be accepted. All switchboards shall be provided with adequate lifting eyes, which shall be removed after the boards are in place and replaced by screw-in plugs. When a switchboard is sectionalized for assembly on site, the sections shall be provided with adequate means of locating adjacent sections to ensure accurate alignment.

72. Each switchboard shall be supplied with removable undrilled steel plates for cable glands ,closed type or multi layers or adjustable types at the cable or conduit entry side. Whenever single core cables are used the gland plates shall be of nonferrous materials either Aluminum, Brass or non- conducting material . All conduits, trunking and cables as shown on the Drawings, shall be accurately located and drilled, cut and threaded on site.
73. LV switchboards shall be enclosed with lockable doors. All "live" metal shall be insulated and the operator shall not be able to accidentally come into contact with "live" connections or busbars when energized. All cable terminations shall be fully shrouded and shall permit connections to be made with adjacent circuits live.
74. All equipment mounted in switchboards shall be fully accessible for maintenance. Switchboard compartments shall be fitted with hinged doors, neoprene or foam rubber gasketed, and doors shall be provided with lever type locking handles having integral cylinder locks. All locks shall be operable with a common key, the number of keys supplied being two per lock up to a maximum of 10 per switchboard.
75. Molded case circuit breakers in switchboards shall comply with IEC 60947-2. Switches, fuse-switches, switch disconnectors and disconnectors shall comply with Section 16240 and BS and IEC requirements.
76. Motor starters installed within the Power Distribution Boards shall comply with the requirements given in Section 16423.
77. All disconnectors, switch disconnectors, switches and circuit-breakers shall be provided with the means to enable them to be locked in the ‟off″ position. When used as earthing switches they shall be capable of being locked ‟on″ when closed to the earth connection.
78. Busbars shall be four-pole, air insulated of uniform cross-section throughout their length, with a continuous current rating not less than that shown on the Drawings and shall be arranged horizontally and vertically through each switchboard. Current ratings shall take account of reduction in section caused by drilling for connections and supports.
79. Busbars and the connections from them to the various items of switchgear shall be manufactured from hard drawn high conductivity copper or flexible flat busbar of 1mm thickness sized to the feeder requirements and to be bolted directly to both MCCB and dropper busbars
80. Busbars shall be supported on non-hygroscopic, non-tracking insulators of sufficient strength to withstand, without damage, the forces set up, either by thermal effects during normal operation or by dynamic electromagnetic effects under short circuit fault conditions.
81. Busbars shall be housed in separate compartments, which shall not contain any wiring or apparatus other than that for connecting to the busbars.
82. Access to busbars and busbar connections shall be possible only after the removal of covers secured by bolts or studs. Such covers shall be identified externally by ‟Formica″ engraving laminate labels bearing the inscription ‟BUSBARS″ in black lettering not less than 10 mm high, on a white background.
83. The cross-sectional area of the neutral busbar shall equal that of a phase bar.
84. Each cubicle or box section shall be provided with sufficient busbar links to enable cubicle sections to be easily joined. Facilities shall also be provided for extending the busbars to extra cubicle sections, if required, at some later date.
85. Metering current transformers shall be installed on the incoming side.
86. Supplies for control circuits shall be taken from within the compartment of the related item of switchgear, and a fuse unit fitted with a separate protective device shall be fixed within the compartment to protect the control circuit. Where control circuits pass through auxiliary contacts the protective device shall also be the means of isolation for the terminals of these contacts.

87. Where auxiliary contacts are used for interlocking purposes and supplies are derived from other sources, isolating facilities shall be provided to ensure that the auxiliary contacts can be made safe. The isolating facility shall be in the form of an auxiliary switch on the respective compartment isolating device or a separate isolator mounted within the respective compartment. Where a separate isolator is provided a clear warning, notice made from "Formica" engraving laminate shall be fixed by screws in a prominent position in the compartment stating "WARNING - ISOLATOR AUXILIARY CONTACTS".

88. Where the external cables to or from the switchboard are shown on the Drawings as being PVC or XLPE insulated twin and multi-core cables, armoured or unarmoured, the appropriate units of the switchboard shall be supplied with suitable brass compression glands of the correct sizes.
89. Compression glands for PVC insulated and sheathed twin and multi-core cables shall comply with the requirements given elsewhere in these specifications. All component parts of a cable gland shall be of the same manufacture.
90. All internal connections and small wiring shall be carried out using PVC insulated cables complying with BS requirements and all terminals shall be marked in accordance with BS standards.
91. All small wiring shall be neatly bunched and cleated in harness form, using purpose-made plastic cable ties, or shall be enclosed in purpose-made plastic small wiring trunking. Wiring cleated to metal surfaces shall be spaced off the metal or otherwise insulated from it. Metallic "buckle clips' shall not be used for internal wiring. Wiring to swing doors or other moveable items shall be flexible cables neatly bunched and constrained by a flexible harness.
92. Small wiring to which external connections have to be made shall be terminated on approved type terminal boards which shall be easily accessible and conveniently arranged to facilitate the connection of incoming and outgoing multi-core cables. Each terminal unit shall have separate incoming and outgoing terminals and no more than one wire shall be connected to any one terminal unless the terminal is specifically designed to take more than one. Each terminal board for external wiring shall have at least 10% spare capacity with a minimum of two spare terminals. All terminal boards shall be numbered in sequence to match the numbering on the wiring or connection diagrams.
93. All spare contacts on relays, contactors, and the like shall be wired to easily accessible terminal blocks, as above, suitably positioned for future external wiring.
94. Main earthing terminal shall consist of a copper earth bar sized in accordance with BS/IEC for the prospective short-circuit current. The earth bar shall be unjointed except between cubicle sections and shall extend through the length of the switchboard. The earth bar shall be connected to the earthing conductor via an external test link. earth bar size shall be minimum 25 x 3 mm however for higher LVSG current ratings consider the earth bar 50% of Neutral size . Each cubicle and all protective conductors shall be bonded to the earth bar.
95. A bonding conductor shall connect the earth bar to each gland and/or armour clamp where cables terminate at the switchgear. All equipment which is not specifically earthed separately shall be bonded to the main earth bar.
96. Each switchboard shall be equipped with the instruments, meters, Poly-phase meters and associated apparatus as shown on the Drawings. All instruments, meters and associated apparatus shall comply with the detailed requirements set out elsewhere in this specification under the heading Instruments and Metering.
97. Each incoming and outgoing circuit on the switchboard shall be clearly identified on the front panel by means of an engraved label bearing, in black letters on a white background. The labels shall be of plastic engraving laminate with lettering not less than 5 mm high and shall be secured to the panel front with instrument headed machine screws. Where rear access is available labels shall also be fixed to the rear panels.
98. Warning labels shall be fitted in all places where the removal of covers or access panels may expose live equipment operating at a pressure exceeding 250 V between phases or to earth. Warning labels shall be of plastic engraving laminate with red lettering on a white background, and shall bear the inscription "DANGER - LIVE PARTS OVER 250 V" in letters not less than 10 mm high.
99. All equipment and apparatus, both inside and outside the switchboard, including instruments, meters, and relays, which is not clearly identified by integral labeling, shall be adequately labeled in the manner described above for front-of-panel circuit labels.
100. All fuse-switches, switch-fuses, miniature and molded case circuit-breakers,

disconnectors, switch- disconnectors and distribution boards forming part of low voltage switchboards shall comply with the requirements set out in Sections 16140 and 16420.

101. No switch, breaker or fuse gear in switchboards will be accepted unless it has type test certification to the requirements of the relevant standard from an independent testing authority.

102. A high voltage pressure test shall be carried out with all isolators closed and power fuses fitted but having all control circuits disconnected. The panels shall withstand for one minute a voltage of 2 kV across the following points:

1- Phase t phase

2- Phase to Neutral

3- Phase to Earth

4- Neutral to Earth

103. Works tests on busbars in accordance with the requirements for routine tests shall be included.

104. Approval of tests and test certificates that may be given shall not relieve the Sub-contractor of the obligation to supply the complete equipment in accordance with the requirements of the Specification, Schedules and Drawings.

105. Where designated, the emergency power supply connection shall be an automatic source changeover with the mechanical and electrical interlocking.

2.03 Safety and Accessories

A. MEP and Authorised Panel builder to provide Arc flash study for the complete system (LVSG , Main distribution boards up to lighting and distribution panel boards) to identify ARC risk and ARC flash level at each panel based on which operators should follow certain precautions and procedures when attending operation or maintenance of electrical panels , ARC flash identification colours and signage from dark red , red, orange, yellow green and white to be added to each panel , special accessories to be used for each level

B. The room for main LV power distribution board/switchboard shall be complete with all accessories necessary to form a complete installation including, but not limited to, the following operating and safety accessories taking into consideration the recommendation of arc risk study:
1. One pair of insulating gloves.
2. One rubber mat 10 mm thick x 1000 mm wide and extending the full length of the equipment.
3. Notice and safety instruction chart including first aid chart for electric shock.
4. One set of spare control circuit fuses.
5. Any other equipment necessary to comply with the standards and maintenance/safety requirements.

C. ARC risk tools
1. Helmets
2. Fire Jackets
3. Fire protection glasses
4. Safety isolation shoes

PART 3 EXECUTION

3.01 INSPECTION

1. Install products in accordance with manufacturer's instructions.
2. The MEPD sub-contractor shall install electrical switchboards of wall or floor mounted type, as called for in the specification and drawings.
3. Switchgear manufacturer shall ensure that all boards and components within, including

MCCB's/MCB's are sized to suit the prospective fault current at the point of installation of these devices.

4. Set field-adjustable circuit breaker tripping function settings as per approved protective co-ordination study.
5. Panel key shall be fixed on a chain and shall be made available near the panel.
6. Ensure to coordinate cable entries and locate incomer accordingly as incoming cable will not be allowed to reticulate within the board. Incoming and outgoing cables shall always be reticulated separately and shall not cross.
7. Glazed and framed schematic shall be made available for each panel board at the electrical room to MEPD Engineer's approval.
8. Emergency shut-down procedure and transfer to essential power shall also be described and affixed on a glazed frame on wall.
9. The panel boards are to be fitted with suitable plastic drawing holders for the line diagrams, load schedule and panel as built drawings and bill of materials.
10. All cable and wire terminations, both incoming and outgoing of the functional units, including MCCB's, MCB's and other devices shall be through approved lugs. Functional unit assemblies shall suit the requirement.
11. The position of distribution boards is not to be hindered by any doors. In case of main panel boards the clear space in front of the board shall be 1.5 m and space at the rear and the sides shall be 750 mm minimum.
12. All access and installation arrangement shall be to the requirement of utility and their approval.
13. On completion of the installation, a rubber mat with anti-static properties (running the entire length 4-6mm thick and 1000 mm wide) shall be provided in front of all switchboards to the approval of utility.
14. Cable glands shall also be IP rated to suit the location. IP rating shall be maintained at the gland interface also by purpose made neoprene seal.
15. The Contractor shall examine the rooms, areas and conditions under which the main or sub-main LV power distribution boards/switchboards are to be installed, and correct any unsatisfactory conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.
16. Agree with the manufacturer of the switchboards, the suitability of the Civil Works for foundations which must be compatible with equipment and all sizes and details must be checked and confirmed before concrete is poured, or revised with the approval of the Engineer where necessary. It is the Contractor's sole responsibility to supply all materials and to construct in the correct location, level and true grade, the concrete base, and to connect all incoming and outgoing cables.

3.02 INSTALLATION

A. Installation of LV power distribution boards/switchboards shall be in accordance with manufacturer's written instructions and shall comply fully with the requirements of BS, IEC, Local Standards Organization and recognized industry practices.

B. Install the switchboards on to bases using appropriate lifting equipment to ensure that no damage occurs. When correctly located, the unit shall be anchored in position and tested before and after connecting the incoming and outgoing cables.

C. Supply all material for construction of base in correct location, level and time grade and for connection of all incoming and outgoing cables.

D. Check ratings of all circuit protection devices and fill out the circuit directory card upon completion of installation work.

3.03 FIELD QUALITY CONTROL

A. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

B. Routine Tests- The panel assembler shall perform the routine testing and provide the test

certificates as defined in IEC 61439 standards. The routine test shall include but not limited to the following:

1. Inspection of the assembly including inspection of wiring and electrical operational test
2. Dielectric test & Insulation resistance test
3. Checking of protective measures and of the electrical continuity of the protective circuits
4. Test for all Circuit Breakers.
5. Functional tests as per approved test procedure.
8. Routine test certificates and test reports with all the readings shall be submitted to the MEPD Consulting Engineer for verification.

C. Inspect and test in accordance with BS 7671.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by BS 7671.

E. Test shunt trips, Communication/BMS interfaces to verify proper operation from remote.

F. Correct deficiencies and replace damaged or defective switchboards or associated components.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

H. Comply with Section 16910.

I. Prior to energization of circuiting, check all accessible connections to manufacturer's torque specifications.

J. Prior to energization of panel board, check with earth resistance tester phase-to-phase and phase-to earth insulation resistance levels to ensure requirements are fulfilled. Migger test

K. Prior to energization, check panel board for electrical continuity of circuits and for short circuits.

3.04 ADJUSTING

1. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
2. After wire and cable hook-ups and testing, energize panel boards and demonstrate functioning in accordance with the requirements. Check whether all outgoings are connected as per panel board schedules. Record changes in the schedules for final as built, if acceptable to the Engineer.
3. Adjust alignment of switchboard covers and doors.
4. Adjust circuit breakers, protective relays and other control devices to provide adequate over current protection and selective tripping with downstream devices in accordance with short circuit and protection coordination study and after proper coordination with protection settings of Electricity Supply Authority.

3.05 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard and associated devices.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

3.06 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

3.07 NAME PLATES

A. Comply with Section 16075.

B. Each panel board shall have an affixed engraved nameplate. The nameplate shall be both in

English and Arabic.

C. Each distribution panel board circuit breaker shall be equipped with a nameplate which indicates the name of the equipment (motor, panel board, etc.) to which the feeder conductors are connected. Where more than one piece of equipment or panel board is connected to the circuit this fact shall be indicated on the nameplate. Apply the feeder numbers as shown on the Drawings on the switch nameplates.

END OF SECTION

SECTION – 16420
LV PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. LV Protective Devices installed in LV switchgears, power distribution boards, panelboards, motor control centers, control panels including, but not limited to, the following:
   1. Molded case circuit breakers.
   2. Miniature circuit breakers.
   3. Residual current circuit breakers.
   4. HRC/cartridge fuses.
   5. Instruments
   6. Current Transformers
   7. Metering

1.02 RELATED SECTIONS

A. Section 16050 Electrical Works, General.

B. Section 16075 Electrical Identification.

C. Section 16410 LV Power Distribution Boards.

D. Section 16442 Panel boards.

E. Section 16443 Motor Control Centers.

F. Section 16910 Electrical Testing and Commissioning.

1.03 REFERENCES

A. BS 7671- Requirements for electrical installations: IET Wiring Regulations - Latest edition.

B. EN / IEC 60947-1 & 2 - Low Voltage Switch gear and Control Gear: General Rules and Circuit Breakers; Latest edition.

C. EN / IEC 60898-1 & 2 - Circuit breakers for overcurrent protection for household and similar installations.

D. EN/ IEC 61008-1 – Residual current operated circuit breakers without integral overcurrent protection for household and similar uses (RCCBs).

E. EN/ IEC 61009-1 – Residual current operated circuit breakers with integral overcurrent protection for household and similar uses (RCBOs).

F. IEC 60664-1 - Insulation coordination for equipment within low-voltage systems; Latest edition.

G. IEC 61000-4-1 - Electromagnetic compatibility; Latest edition.
H. IEC 61557-12 - Performance measuring and monitoring devices (PMD): Latest edition.
I. IEC 60068-2 - Environmental testing; Latest edition.
J. IEC 61439 - 1 & 2 – Low Voltage switchgear and Control gear assemblies; Latest edition.
K. IEC 60269 – Low Voltage fuses.
L. IEC 62423 - Type F and type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses
M. Relevant IEC standard for all other products when not specifically stated.
N. Local Authority Requirements and Regulations.

1,04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by BS 7671 and local authorities under jurisdiction.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
   5. Notify Consultant of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Service Entrance Switchgear:
   1. Coordinate with utility to provide switchgear with suitable provisions for electrical service and utility metering, where applicable.
   2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
   3. Obtain utility approval of switchgear prior to fabrication.
   4. Pre-installation Meeting: Convene minimum one week prior to commencing work of this section to review requirements with Utility Company representative.
   5. Arrange for inspections necessary to obtain utility approval of installation.

1.05 SUBMITTALS

A. MEPD Scope of Works, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchgear, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of overcurrent protective device.

C. Shop pDrawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, short-time current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of switchgear and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
   3. Include documentation demonstrating selective coordination upon request.
   4. Include key/cable-type mechanical interlock schemes with sequence of operations, as applicable.
   5. Include proposed mimic bus single-line diagram arrangement.

D. Service Entrance Switchgear: Include documentation of utility approval for switchgear.

E. Source Quality Control Test Reports: Include reports for tests designated in IEC 61439 and IEC 60947 standards as production (routine) tests.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Field Quality Control Test Reports.

H. Project Record Documents: Record actual installed locations of switchgear and final equipment settings.

I. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

J. Maintenance Materials: Furnish the following for owner's use in maintenance of project.
   1. Circuit Breakers:
      a. Electronic Trip Units: Provide one portable secondary injection test set.
      b. Handles Necessary for Racking of Devices: One for each electrical room containing draw-out switchgear.
      c. Portable Lifting Devices: One for each electrical room containing draw-out switchgear with no integral top rail-mounted lifting device.
      d. Removable Covers: One for blocking each different opening size when circuit breaker is temporarily removed from its compartment.

1.06 QUALITY ASSURANCE

A. Conform to the requirements of relevant IEC, EN and BSEN standards.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover/wrappings to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

E. Inspect equipment to ensure that no damage has occurred during shipment.

1.08 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.

4. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
5. Technical performance of the equipment selected.
6. Dimensional details needed for installation and maintenance.
7. Copies of test reports or certificates.
8. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

C. Submit factory test reports verifying that all the LV protective devices have successfully passed all routine and type tests.

1.05 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of protective devices of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. All LV protective devices to be conform to the requirements of BS, IEC and Local Standards Organization.

1.06 SPARE PARTS

A. Unless otherwise specified, supply as maintenance stock, additional LV protective devices of all types and ratings, amounting to one unit for every 10 installed units, but not less than two units of each type and rating.

1.07WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials specified herein shall be of high quality and of proven suitability for the functions they will perform and the conditions they will meet in services.

B. For remote monitoring/controls, comply with the requirements of Building Management System.

2.02 MOULDED CASE CIRCUIT BREAKERS

A. Quick-make, quick-break type, with positive trip-free operation so that contacts cannot be held closed against overcurrent under manual or automatic operation. Contacts shall be non-welding silver alloy with approved arc-quenching devices of metallic grid construction.

B. All Molded Case Circuit Breakers (MCCBs) serving as incomers and protecting outgoing feeder circuits shall be designed and constructed to have ultimate short circuit breaking capacity (Icu) of not less than 50 KA at MDB level, 36KA at SMDB & MCC level at 415V, 50Hz operational voltage and shall conform to the requirements, including latest amendments, of IEC / EN /BSEN 60947-2. Ics rating of MCCBs shall be 100% of Icu rating and as a minimum shall be more than the prospective 3-Phase maximum short-circuit level calculated at the respective switchboard level.

C. All MCCBs shall be suitable for continuous operation at full load at an ambient temperature of 50° C and shall have distinct ON, OFF, TRIP positions. Tripped indication shall be clearly shown by the breaker handle taking a position between ON and OFF.

D. MCCB shall have a minimum 160 A frame-size, unless otherwise shown on the drawings. Current rating up to 1600A shall be covered in not more than 4 frame-sizes.

E. MCCBs shall be of utilization category/selectivity category 'A' up to 630A frame-size and utilization /selectivity category ‘B’ for frame size above 630A. MCCBs up to 630A frame-size rating shall be of current limiting type. Data sheets/let-through curves shall be submitted in proof of compliance.

F. All MCCBs in MDBs of rating above 100A shall have electronic protection release/trip unit with adjustable overload& adjustable short circuit trip setting ranges. MCCBs of rating up to 100A shall be with thermo-magnetic release having adjustable overload & adjustable magnetic trip settings.

G. All MCCBs in SMDBs of rating 400A and above shall have electronic protection release/trip unit with adjustable overload& adjustable short circuit trip setting ra nges. MCCBs of rating up to 400A shall be with thermo-magnetic release having adjustable overload & adjustable magnetic trip settings.

H. MCCBs in MDBs of rating above 100A shall provide LSI protection with electronic trip units.

I. MCCBs in SMDBs shall provide LI protection with electronic/thermomagnetic trip units.

J. All circuit breakers shall be 3-pole unless otherwise shown on the drawings.

K. Electronic trip circuit breakers shall have solid state trip units with long time delay setting range at least between 0.5 and 1.0 times trip unit rating with adjustable time delay up to 20 seconds, short time delay range 2 to 10 times overload setting with maximum clearing time of 1 second, and instantaneous protection adjustable from 2 to 12 times trip unit rating. Solid state trip units shall be insensitive to changes in ambient temperature between -20 and +50 deg. C. Earth fault protection shall be externally provided or built into the trip unit, where specified or shown on drawings, and shall be adjustable between 0.2 and 1.0 times trip unit rating with a maximum time delay of 1000 ms.

L. All thermo-magnetic MCCBs shall have nominal current rating declared at an ambient temperature of 50° C. MCCB data sheet shall be submitted in proof of the same.

M. MCCB shall have provision to receive a locking device in the "OFF" position and there shall be a "push to trip" button in front to test the opening of the breaker.

N. Rated insulation voltage (Ui) shall be not less than 690V, rated impulse withstand voltage (Uimp) not less than 6kV and rated operational voltage (Ue) not less than 415V.

O. Selectivity tables from the manufacturer shall be provided showing discrimination levels between outgoing feeder MCCBs in MDBs with corresponding MCCBs in downstream SMDBs and outgoing feeder MCCBs in SMDBs with MCBs in final DBs.

P. All MCCBs feeding emergency supplies shall be of plug-intype where applicable.

Q. Endurance of the MCCB should be equal to or more than 10,000 operations.

R. MCCBs shall allow addition of electrical motor operator, control and interlocking accessories, under-voltage release, shunt-trip coils, alarm and auxiliary switches, padlocking devices, key- locking devices, rotary handles etc.

S. External door-coupling rotary handles of MCCBs shall have an IP66 degree of protection.

T. Motor operator shall have Manual/Auto modes of operation, padlocking & sealing provisions, breaker ready-to-close indication & contact, mechanical ON/OFF/Spring charged indications, manual charging handle and with a closing time of not more than 100mS.

U. Where draw-out MCCBs are specified elsewhere in the specifications/drawings in the MDBs, proposed draw-out MCCBs shall have three distinct positions connected, test and disconnected. Safety interlocks and padlocking provision in each position shall be standard. Cranking handle shall be used to rack-in and rack-out moving breaker part within the chassis. Provision shall be given to install position switch and clear mechanical indication of the three positions shall also be provided.

V. MCCBs with electronic trip units in MDBs are to be capable of interfacing with the provided control systems (BMS/SCADA/DCS) via adequate data link integration to transfer/receive the required signals indicated in the schedules/drawings, and the followed communication protocol is to be matched/coordinated with the BMS/SCADA/DCS supplier wherever specified in the drawings.

W. Electronic trip unit MCCBs shall provide metering/on-off/trip data wherever shown on the drawings or as per the I/O table of BMS/SCADA/DCS.

X. While testing switchboards at the factory / project site, MCCB trip units shall be tested using handheld secondary injection test kits / dedicated trip unit testing software tools to verify declared trip times. MCCB trip units shall have appropriate testing port to test the trip unit time-current curves (LSI) and the current sensors functionality, using built-in trip unit secondary injection circuit. If not available such injection test preferable internal built in secondary injection capabilities of the MCCB can do the job

Y. Extra facilities may be required, such as shunt trips, under-voltage release, auxiliary switches, remote indications or tripping, residual current protection or special calibrations. Such extra facilities shall be specified elsewhere in this Specification or as shown on the Drawings.

Z. The short circuit interrupting capacity of all MCCB′s and MCB′s in any panelboards, MCC, power distribution board/switchboard, control panel, etc. shall not be less than the short circuit rating of the main busbars, as shown on the Drawings and Schedules.

2.03 MINIATURE CIRCUIT BREAKERS (MCB's)

A. All MCBs shall be of current limiting type, complying with energy limiting class-3, with trip free mechanism, designed and type tested to IEC / EN / BSEN 60898.

B. MCBs shall be DIN rail mounting type and with minimum10KAshort circuit breaking capacity (Icn) asperIEC60898-1 & 2 standards.

C. It shall be possible to remove each MCB individually without having to disturb/remove the busbars fitted to it. Clear contact position indication (red/green) shall be provided at the front of the device. Terminal markings shall be printed near to the terminals for error free wiring.

D. MCBs shall have thermal tripping element and a magnetic tripping element, both non-adjustable type, tested in accordance with IEC 60898 product standard. MCBs shall be of Type-B characteristics for

lighting circuits and Type-C characteristics for power circuits. MCBs of tripping curve Type-D shall also be available for heavy starting duty application if required.

E. Preferred rated currents shall be 6, 10, 16, 20, 25, 32, 40, 50 & 63A and available as 1P, 2P,1P&N, 3P, 3P&N & 4-pole circuit breakers.

F. Terminals of MCB shall be of dual function for connection of busbar or wire.

G. MCB shall be suitable for operation at an ambient temperature of 50°C. The life expectancy shall be at least 4,000 mechanical operating cycles and 20000 electrical operating cycles.

H. MCBs shall have provision for subsequent fitting of auxiliary and trip indicating switches.

I. Rated insulation voltage (Ui) shall be 415VAC and rated impulse withstand voltage (Uimp) shall be 4 kV minimum.

J. Test certificates proving compliance to IEC 60898 for declared electrical parameters shall be submitted for approval.

2.04 RESIDUAL CURRENT CIRCUIT BREAKERS

A. In addition to the over current and short circuit protection afforded by MCBs, circuits shall be RCCB protected with appropriate sensitivity as per utility approved schedules conforming to IEC / EN 61008 & IEC 62423 to provide personnel protection against shock and earth leakage.

B. The RCCBs as shown on approved schedules shall be current-operated residual current devices using the core balance transformer principle and a permanent magnet tripping device trip free construction. The devices shall have a test button and shall have provision for subsequent fitting of auxiliary and trip indicating switches.

C. The MEP sub-contractor shall coordinate with equipment suppliers and ensure that there is no duplication of ELCB/ELS between switchboards and equipment control panels.

D. RCCB shall be of type 'A' sensitive to AC and pulsating DC. Rated insulation voltage (Ui) shall be 440V AC and rated impulse withstand voltage (Uimp) shall be 4kV. Rated conditional short-circuit strength (Inc) shall be 10kA in line with IEC 61008 standard.

E. RCCB shall be suitable for operation at an ambient temperature of 50°C. The life expectancy shall be at least 4,000 operating cycles.

F. Where indicated, SP&N RCBOs of 10kA rated breaking capacity shall be proposed complying with the requirements of IEC 61009 standard.

G. Test certificates proving compliance to IEC 61008 shall be submitted to prove compliance.

H. The sensitivity of the RCCB's shall be one of the following based on type of circuit protected and the sensitivity required 10, 30, 100,300 500mA or differential 0 to 5 A as required and shown on the Drawings and load Schedules with a maximum tripping time of 30 milliseconds.

I. Each breaker shall incorporate a test circuit with a test button to simulate fault conditions.

D. The combined units shall be compatible with other MCB's installed within distribution boards.

2.05 RESIDUAL CURRENT RELAYS (Earth Leakage Relays) & TOROIDS

A. Relay:

a. The relay shall comply with IEC60755, IEC 1008 and IEC 1009 and s h o u l d be time &current settable.

b. The relays shall be protected against nuisance tripping caused by switching surges or by lightning surges.

c. The relays shall be protected against vibration and ingress of dust, vermin &moisture.

d. The relays shall beable to operate in the presence of fault currents with DC components.

e. Each relay shall accept a wide range of auxiliary supply voltages and shall be as per requirements shown in the drawings.

f. The sensitivity of relays shall be as per the requirement in the drawings from 0.03A to 5A, fixed or adjustable current & time settings as per the application.

g. The relays shall be compact in size. They shall be suitable for mounting on asymmetrical DIN rail horizontally or vertically.

h. The relays shall be equipped with minimum one changeover output contact. The continuity of measurement circuit shall be monitored to ensure that the toroid circuit is not open and suitably signaled using LEDs. TEST and RESET pushbuttons shall be available on the front of the relay.

B. Current Sensors (Toroids) shall be circular/ringtypefor cable feeders suitable for cable cross-sections ranging from 0.5 to 300 Sq.mm.

C. Diagnostic functions shall be provided with LED's flashing at different frequencies for different values of fault currents.

CURRENT TRANSFORMERS

A. Current transformers shall be of the bar primary type, air cooled and suitably insulated. They shall be of Class 1 accuracy for measurements, Class 0.5 for KWH meters and of Class 10 P10 accuracy for protection in accordance with IEC 61869-2. The secondary windings shall be rated at 5A and threated output shall be suitable for the burden.

B. All connections to CTs shall be done through CT shorting links using minimum 2.5 Sq. mm size control wire.

C. CTs for authority meters shall comply with utility regulations.

D. Current transformers shall be adequately supported and installed as to permit easy access for maintenance. They shall be placed in such a way that CT rating plates and markings are always visible and installed by observing the minimum clearance distances.

E. CT ratios shall be verified during routine testing at the panel builder works.

2.06 INSTRUMENTS

A. The measuring instruments shall include ammeters, voltmeters, maximum demand indicators and selector switches as indicated on the drawings.

B. Theinstrumentsshallhaveanti-glareglassfronts,anti-parallaxscales and whitefaces with black numerals and markings. The length of scales shall not be less than 90 degrees and uniformly divided. The instrument cases shall be semi-flush mounted and shall be approximately 96 x 96 mm square. Accuracy shall be one per cent of full-scale values. Moving elements shall be provided with zero adjustments external to the cases.

C. Ammeters shall be moving iron type, to IEC 60044 & 60051-1 scaled 0-2500A for main incoming supply. Ammeter shall carry CE marking and shall have certified compliance to IEC / BS EN 60051.

D. Voltmeters shall be moving iron type to IEC 60044 & 60051-1 scaled 0-500V andprovidedwith7-position select or switches allowing reading of line to line and line to neutral voltages. Voltmeter shall carry CE marking and shall have certified compliance to IEC /BS EN 60051.

E. Maximum demand indicators shall be of the thermal type with a 20- minute time delay.

F. Ammeters shall be capable of taking continuous overload of 2 times and Voltmeters capable of 1.2 times overload.

G. All terminals shall be completely insulated, and potential circuits shall be suitably fused with caution labels.

2.07 HRC/CARTRIDGE FUSES

A. HRC/cartridge fuse links shall be of the high rupturing capacity (HRC) type and shall comply with IEC 269 – 2 requirements.

2.08 POWER & ENERGY METERING (PMU/EMU)

A. The EMU shall be electronic, panel mounted type suitable for 3 Phase, 4 wire application with external CT connections. It shall be dust & vermin proof and of robust construction.

B. The EMU shall be suitable for 415/240 Volts 3 Phase 4 Wire, 50 Hz supply and comply with IEC 61036, IEC 62053-31 and IEC 61268 standards.

C. Accuracy shall be Class 1 for active energy.

D. The EMU shall have a backlit LCD display on the front facia with functional buttons for measurement and programming.

E. The rear panel of the EMU shall have fixed terminal block for CT current input and plug-in terminal block for voltage input & power supply.

F. The display shall provide following measurements as a minimum

1. Voltage
2. Current
3. Frequency
4. Power Factor
5. Maximum Demand
6. Active, Reactive and Apparent Power
7. Active energy KWH, Apparent energy KVAh and Apparent energy KVARh
8. Total Harmonic Distortion for Voltage and Current
9. Amplitude of current and voltage harmonics up to 31st Harmonics

G. The EMU shall be suitable for continuous operation at an ambient temperature of 50 degree C.

H. The EMU shall have programmable CT and VT ratios.

I. The EMU shall have a pulsed energy output and a serial communication RS 485 port. It shall be capable of transmitting all measured data over a communication network using MODBUS protocol as standard.

PART 3: EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings and configurations of the switchgear and associated components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive switchgear.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions and complying with utility regulations. Install protective devices as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure compliance with BS, IEC and Local Standards Organization standards.

B. Arrange equipment to provide required clearances and maintenance access, including accommodations for draw-out circuit breakers.

C. Provide grounding and bonding in accordance with Section 26 0526.

D. Install all field-installed devices, components, and accessories.

E. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

F. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

G. Set field-adjustable circuit breaker tripping function settings as per approved protective co-ordination study.

H. Coordinate with other work, including electrical wiring work as necessary to interface installation of protective devices with other work.

I. Fasten circuit breakers without mechanical stresses, twisting or misalignment being exerted by clamps, supports or cable.

J. Set field-adjustable circuit breakers for trip settings as indicated, subsequent to installation of devices.

K. Install fuses, if any, in fused circuit breakers.

L. Inspect circuit-breaker operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

3.03 FIELD QUALITY CONTROL

A. Comply with Section 16910.

B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

C. Before energizing switchgear, perform pre-operation checks in accordance with respective IEC standards.

D. Inspect and test in accordance with BS 7671 and respective IEC standards.

E. Test shunt trips and communication/BMS interfaces to verify proper operation.

F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

G Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and current injection for trip tests. Correct malfunctioning units and then demonstrate compliance with the requirements.

END OF SECTION

SECTION - 16440
PANEL BOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Lighting and Power Panelboards including cabinet cut out boxes and enclosures
B. Final Distribution Boards.

1.02 RELATED SECTIONS

A. Section 16050 Electrical Works, General.

B. Section 16075 Electrical Identification.

C. Section 16420 LV Protective Devices.

D. Section 16060 Grounding and Bonding Systems.

E. Section 16910 Electrical Testing and Commissioning.

1.03 REFERENCES

Q. BS 7671- Requirements for electrical installations: IET Wiring Regulations - Latest edition
R. IEC/EN/BSEN 60947-1 & 2 - Low Voltage Switch gear and Control Gear; General Rules and Circuit Breakers - Latest edition.
S. EN / IEC 60898 - Circuit breakers for overcurrent protection for household and similar installations.
T. IEC 60664-1 - Insulation coordination for equipment within low-voltage systems; Latest edition.
U. IEC 61000-4-1 - Electromagnetic compatibility; Latest edition.
V. IEC/EN/BSEN 61439-1 & 2 - Low-voltage Switchgear and Control gear assemblies; Latest edition.
W. IEC 61557-12 - Performance measuring and monitoring devices (PMD); Latest edition.
X. IEC 60068-2 -Environmental testing; Latest edition.
Y. Guide to Forms of Separation – BSEN 61439-2 (BEAMA) Low Voltage Switchgear and Control gear assemblies.
Z. IEEE 519 – Recommended Practices and Requirements for Harmonic Control of Electrical Power Systems.
AA. IEC 60269 – Low voltage fuses.
BB. IEC 60529 – Degrees of protection provided by enclosures (IP Code)
CC. IEC/TR 61641 – Guide for testing under conditions of arcing due to internal faults.
DD. IEC 60909 – Short-circuit currents in 3 phase AC systems calculations.
EE. Relevant IEC standard for all other products when not specifically stated. FF.
Local Authority Requirements and Regulations.

1.04 SUBMITTALS

P. Contractor shall be responsible for carrying out the Voltage drops, Harmonics, Short circuit and Earth fault current calculations, Protective discrimination and Reactive power compensation studies for the entire LV distribution system. Detailed reports shall be submitted for approval.

Q. A protective device coordination study shall also be carried out to ensure that all protective devices are fully coordinated & discriminated based on specific tripping curves of protective devices proposed and considering specific calculated prospective short-circuit currents at various levels in the distribution network.

R. These studies and calculations shall be based on the actual devices, loads, bus risers and cable lengths installed.

S. The LV schematics shall be prepared on the basis of this study and shall be to the approval of the MEPD Engineer.

T. Product Data: Provide manufacturer's standard catalogue pages and data sheets for switchboards, enclosures, overcurrent/earth fault protective devices, and other installed components and accessories.
   a. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.

U. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   a. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
   b. Include wiring diagrams showing all factory and field connections.
   c. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   d. Include documentation of listed breaker frame/trip ratings upon request.
   e. Include documentation demonstrating protective coordination upon request.

V. Workshop drawings final Distribution Boards shall be submitted to the MEPD Engineer for approval and shall indicate the following:
   a. General arrangement drawing.
   b. Bill of Materials.
   c. Protective device types, characteristics and ratings.
   d. Dimensioned drawing.
   e. Cable entry details.
   f. Schedule of labels.

W. As-Built (record) Drawings: Submit hard and soft copies. Carry out specified routine & field tests and submit test sheets after taking approvals on the testing formats.

X. Source Quality Control Test Reports: Include reports for tests designated in IEC 61439 as production (routine) tests.

Y. Field Quality Control Test Reports.

Z. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals. Manufacturer’s written instructions for testing and setting overcurrent protective devices. Time-current curves for each type of protective devices.

AA. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   a. Enclosure Keys: Two of each different key.
   b. See Section 26 2813 for requirements for spare parts, fuses and spare fuse cabinets.

BB. Contractor shall submit a calculation report using a recognized software for the whole LV network showing the load flow analysis, Load profiles, 3 Phase and 1 Phase short circuit current as per IEC 60909, Voltages drops and Arc flash assessment to IEEE 1584. The calculation software shall allow non-identical generator paralleling and shall consider motor contribution in the short circuit calculation. The software shall consider real manufacturer mathematical models of equipment's (transformers, generators, cables, busduct etc.)

N. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

17. Name of the manufacturer.
18. Country of origin.
19. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.
20. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
21. Technical performance of the equipment selected.
22. Dimensional details needed for installation and maintenance.
23. Copies of test reports or certificates.
24. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

1.05 QUALITY ASSURANCE

A. Conform to the requirements of relevant IEC/EN and BSEN standards.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Appointment of Specialist Contractor
1. The contractor shall hand over to the MEPD Engineer a complete photographic record of the survey. Switchgear manufacturer shall ensure to coordinate and offer all assistance to the specialist contractor in this regard.
4. If the load available at the time of handover is not sufficient enough for the infrared testing, then the same shall be done during the defects liability period in coordination with the Client and the MEPD Engineer.

D. Manufacturer Qualification: A firm regularly engaged in the manufacture of LV Switchboards of types, sizes and capacities required and whose products &equipment's have been in satisfactory use in similar service for not less than five years.

F. Installer qualification: Engage an experienced installer with minimum five years of successful installation experience on projects utilizing LV distribution board units similar to those required for this project.

G. Comply with applicable local regulations/codes/requirements of authorities having jurisdiction.

H. Complete design verification certification of proposed DBs to IEC/EN 61439-1&2 and IEC/TR 61641 (where applicable) shall be provided which has been issued by an internationally accredited independent certifying body such as ASTA, DEKRA etc. Accreditation of the certifying body as well as the testing laboratories shall be submitted for approval.

i. All panelboards shall comply with the requirements of BS, IEC and Local Standards Organization.

1.06 DELIVERY, STORAGE AND HANDLING

G. Handle Panelboards and enclosures carefully to prevent breakage, denting or scoring the finish.

H. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions.

I. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

J. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover/wrappings to protect units from dirt, water, construction debris, and traffic.

K. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

L. Inspect equipment to ensure that no damage has occurred during shipment.

1.07 SPARE PARTS

A. Unless otherwise specified, supply as maintenance stock, additional circuit breakers, relays and fuses of the panelboards, amounting to one unit for every 10 units, but not less than 5 units of each type and rating.

1.08WARRANTY

C. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions or 1 year from the date of the substantial completion of the project

D. Provide complete system warranty in which the Manufacturer and Contractor are jointly and severally liable and agree to repair/replace all defective components of the warranted system. Warranty shall include both material s and workmanship.

PART 2 PRODUCTS

2.01 GENERAL

25. All materials specified herein shall be of high quality and of proven suitability for the functions they will perform and the conditions they will meet in service.

26. For remote monitoring/controls, comply with the requirements as given in Section 15180.

27. Products other than specified under basis of design are subject to compliance with project requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

28. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and all obtained from a single supplier.

29. All final distribution boards shall be IP 41/IP42 rated type DB for recess and surface mounting in dry areas. For surface installation in plant rooms and near water/wet areas, the boards shall be IP 55 rated.
30. All outgoing feeder MCB's and control/metering equipment on boards shall be clearly labelled by means of engraved traffolyte labels to indicate the function of all equipment, and sub boards and circuits fed from each feeder MCB.
31. The distribution boards shall be supplied complete with adequately sized good quality plastic pouch for insertion of approved load schedule. The arrangement shall be to MEPD Engineer’s approval.
32. Each MCB module shall be numbered consecutively with engraved trifoliate labels. refer respective section for MCB & ELCB specifications.
33. Each board shall be provided with an engraved label indicating designation and size plus origin of feeder cable plus earth wire.
34. All comb bus bars / pan-assembly busbars and shall be made of high quality, high conductivity tinned copper. Pan-assembly DBs shall be fully design verified and certified by ASTA/DEKRA or equivalent independent certifying bodies in full compliance with IEC/EN 61439-3 assembly standard. Certificates shall be provided to ensure compliance. Pan-assembly DBs shall be tested and certified for a short-time withstand rating Icw of 17.5kA for 0.25 seconds as per IEC 61439-3.
35. All breakers, ELCB’s and other components are to be clearly labelled, providing a clear and permanent indication of the circuit reference and the plant protected. Each group of MCB’s shall be installed besides its relevant ELCB for ease of identification and fault finding wherever applicable.
36. Neutral and earth bars shall be of adequate capacity for present and future circuits (one conductor per terminal) and shall be terminated using proper ferrule/lug.
37. All contactors specified shall be rated for AC-3 duty, with 230V continuously rated coils.
38. Incoming cable shall be terminated directly to the incoming isolator. Ensure to coordinate cable entries and locate incomer isolator accordingly as incoming cable will not be allowed to reticulate within the distribution board. Incoming and outgoing wires shall always be reticulated separately and shall not cross.
39. MCBs used in the final distribution boards shall have rated breaking capacity Icn of 10kA as per IEC 60898.
40. All components shall be suitable for continuous operation at the specified ambient temperature.
41. All time switches specified shall be of the quartz type for 24/7 operation with minimum 50-hour rechargeable battery reserve.
42. Rated operational voltage Ue of the distribution board shall be 415 volts, 3phase, 50Hz.
43. Rated insulation voltage Ui shall not be less than 415 volts and the rated impulse withstand voltage Uimp shall not be less than 4kV.
44. Incoming terminals of main incomer switches shall be effectively shrouded to prevent inadvertent contact with live terminals, when the switch is in the "off" position.
45. All live parts shall be effectively shrouded.

2.02 PANELBOARD CONSTRUCTION

1. The technical requirements showing bus size, size and number of branch circuit breakers, branch circuit loads and wiring as provided for each panel board in the Contract Documents shall be followed for guidance and panelboards shall be upgraded for actual site requirements before fabrication.
2. Interior components shall be mounted on back plate of reinforced steel for rigid support and accurate alignment.
3. One flat key tumbler cylinder type door lock with two keys per lock shall be provided.
4. Provide enclosure earthing in accordance with requirements given in Section 16060.
5. Bus bars shall be hard drawn high conductivity copper, with silver plated contact surface.
6. Provide circuit breakers in accordance with Section 16420. Provide two adjacent single pole breakers to opposing polarities in such a manner that two pole breakers can be installed in any location. The same shall be provided for three adjacent single pole breakers to opposing polarities.
7. Neutral and ground buses shall be of the same rating as the phase bus.
8. separate earthing bus, marked with a yellow green strip along its front and bonded to the steel cabinet, shall be provided for connecting all earth conductors. Bus bars shall be copper, shall be securely fastened to bases, and shall not depend upon breakers for support. All main buses and back pans shall be so designed that branch breakers may be changed without additional machining, drilling or tapping
9. Panelboard assemblies shall be so designed that any individual breaker can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as a means of obtaining clearances.
10. Provide panelboard accessories and devices including, but not necessarily limited to, cartridge and plug time-delay type fuses, circuit breaker, earth fault protection units, etc., as recommended by panelboard manufacturer for ratings and applications indicated.
11. One 25 mm wide laminated plastic name plate shall be attached by means of stainless-steel rivets or permanent adhesive, showing panelboard number in 13 mm white cut-in letters on black background. All labeling and identification shall be in accordance with section 16030.
12. A directory holder with clear plastic or glass plate and metal frame shall be mounted on the inside of each door.
13. Protection degree shall be a minimum of IP 41/42 for indoor and IP 54 for outdoor installations.
14. Construction shall allow maintenance of incoming line terminations, main device connections and all main bus bolted connections to be performed without rear access.

2.03 LIGHTING AND POWER PANELBOARDS

1. The lighting and power panelboards shall be of the dead front type with bolt-on circuit breakers in the mains, if indicated, and branches. The panelboards shall be designed for 400/230 V as shown on the Drawings, 3-phase, 4-wire, 50 Hz application.
2. The lighting and power panelboards shall be equipped with bolt-on type circuit breakers. Circuit breaker ratings shall be as shown in the panelboard schedules.
3. Continuous current rating of busbars shall be as shown on panelboard schedules.
4. Where a main protective device is not shown, provide disconnect switches. Bus bar and branch devices shall be of the sequence-phase type connections.
5. Neutral and grounding bars shall be mounted at the opposite end of the structure from the mains and with numbered terminals for connection of neutral and grounding wires.

2.04 DISTRIBUTION PANELBOARDS

A. The enclosures shall be of 2 mm thick electro-galvanized sheet steel structures for floor mounting panels with not less than 1.5 mm covers except for doors 2mm thick, and 1.2-1.5 mm thick for wall mounted folded type panels and shall be electrostatic epoxy powder coated. Mechanical impact strength of the enclosure shall be IK07 to IEC 62262. Dead front assembly type

B. The panel boards shall be minimum IP42 rated for indoor application and IP54 for outdoor and the form of construction shall be Form 2b type 2 design verified in full compliance with BSEN / IEC / EN 61439-2 standard for ratings below or equal to 630A and Form 3b type 2 for higher than 630A and at an ambient temperature of **40**-**50**deg C depending on area of use (Climatic conditions)

C. All floor mounted panels shall have cubicles with front hinged doors and shall have an earth braid/wire connected to the frame.

D. It shall be ensured that all live parts are shrouded.

E. Certified rigid metallic partitions shall be used in the switchgear assembly.

F. Bus bars shall be of the sizes indicated, and shall be of copper, mounted on bus bar insulators.

G. Bus bars shall be sized, supported and spaced to withstand the specified fault currents without damage or distortion based on the short-circuit study and the requirements of the design Engineer.however Minimum short circuit rating shall be 25kA for 1 sec for lower ratings of 400A and less and36kA for 1 sec for assembly ratings above 400A. unless the short circuit study requires higher than the minimum requirements

H. Copper bus bars shall be of high purity, hard-drawn copper for dry locations and hard-drawn tinned copper for areas where wet conditions and/or high humidity is expected , covered and sleeved with heat shrinkable PVC of not less than 1000V insulations specially for tined copper.

I. Sizes of main busbars and connection links to breakers proposed shall not be different the type tested configurations. Design verification test certificates shall be submitted in support of the same. Preferably hard copper connection or PVC covered flexible copper busbarsbetween main dropper busbars to avoid using cable connections specially for rating above than 100A

J. All busbars must be accessible from the front.

K. Color sleeving for phase and neutral/earth circuits shall be used wherever possible. These arrangements shall be however to the approval of utility. All the wiring within the panel to be contained within segregated section with warning labels.

L. All circuits on multiphase distribution boards shall be equally balanced over the three phases to the satisfaction of the MEPD Consulting Engineer.Preferable to verify load balance using any short-circuit -voltage drop and load distribution software's supplied by the same switchgear and protection devices (MCCB's-MCB's) manufacturer based on IEC61439

M. Indicating instruments, surge arrestors, integrating instruments, time switches, relays etc. shall be mounted in a separate compartment wherever applicable.

N. Sub main distribution boards shall be fully design verified according to IEC 61439 by internationally accredited certifying bodies like ASTA/DEKRA or equivalent independent certifying bodies. Certificates shall be provided to ensure compliance. Testing laboratories shall be independent internationally accredited laboratories. Supporting documents in full shall be submitted when requested for

O. Individual ELCB/ELR (as required by utility) shall be provided for every equipment within the respective panels where shown on the schematic drawings. All ELCBs shall be 30mA/100mA/300mA as applicable & ELR 0-3000mA adjustable. Fault rating of ELCB/ELR shall suit the prospective short circuit values calculated at the point of installation.

P. For essential life safety panels and equipment, ELR shall indicate an audio-visual alarm on the panel and relay the same to the BMS. But for non-essential panels, ELR shall trip the upstream MCCB via a shunt trip attached to the MCCB.

Q. Rated operational voltage Ue of the panelboard shall be 415 volts, 3phase, 50Hz.

b. Rated insulation voltage Ui shall not be less than 690 volts and the rated impulse

withstand voltage Uimp shall not be less than 6kV. Test certificates shall be submitted in proof of the same.

A. Ensure to coordinate cable entries and locate incomer accordingly as incoming cable will not be allowed to reticulate within the board. Incoming and outgoing cables shall always be reticulated separately and shall not cross.

B. Each panel board shall be fitted with a plastic drawing holder, internally mounted with as built load schedule, schematics and as built panel drawings.

C. Each panel shall be provided with incomer door interlocked MCCB/non-auto MCCB and shall along with the outgoing MCCBs present a composite appearance. Panel key shall be fixed on a chain and shall be available near the panel. Outgoing MCCBs shall offer LI overcurrent protection with thermomagnetic / electronic trip unit and shall be of the same series as verified in the design verification tests.

D. Each panel shall be provided with voltmeter and selector switch, ammeters and selector switch and RYB phase indicators at the incoming section.

E. All SMDB's shall be provided with test class II surge protection devices complying with IEC 61643-1 and with surge discharge current rating of Imax 40kA

F. All contactors specified shall be rated for AC-3 duty, with 240V continuously rated coils.

G. Each distribution panel shall be enclosed in a sheet metal cabinet with front doors, catches, locks, etc. Locks shall be fitted for the same key as locks on other lighting and power branch circuit panelboards. All distribution panelboards shall meet pertinent standards.

H. The distribution panelboards shall be equipped with bolt-on circuit breakers. Circuit breaker ratings shall be as shown on the distribution board schedules.

I. Current-carrying connections to bus shall be of the bolted type, factory assembled. Bus bars shall be of the sequence-phase type connections and arranged for 3-phase, 4-wire mains or lugs.

J. Mount the neutral bar at the opposite end of the structure from the mains and with have numbered terminals for connection of neutral wires.

2.05 NAME PLATES

A. Comply with Section 16075.

B. Each panelboard shall have an affixed engraved nameplate. The nameplate shall be both in English and Arabic.

C. Each distribution panelboard circuit breaker shall be equipped with a nameplate which indicates the name of the equipment (motor, panelboard, etc.) to which the feeder conductors are connected. Where more than one piece of equipment or panelboard is connected to the circuit this fact shall be indicated on the nameplate. Apply the feeder numbers as shown on the Drawings on the switch nameplates.

PART 3 EXECUTIONS

3.01 INSTALLATION

17. Install products in accordance with manufacturer's instructions.
18. The MEPD sub-contractor shall install electrical switchboards of wall or floor mounted type, as called for in the specification and drawings.
19. Switchgear manufacturer shall ensure that all boards and components within, including

    MCCB's/ACB's/MCB's are sized to suit the prospective fault current at the point of installation of these devices.
20. Set field-adjustable circuit breaker tripping function settings as per approved protective co-ordination study.
21. Panel key shall be fixed on a chain and shall be made available near the panel.
22. Ensure to coordinate cable entries and locate incomer accordingly as incoming cable will not be allowed to reticulate within the board. Incoming and outgoing cables shall always be reticulated separately and shall not cross.
23. Glazed and framed schematic shall be made available for each panel board at the electrical room to MEPD Engineer's approval.
24. Emergency shut-down procedure and transfer to essential power shall also be described and affixed on a glazed frame on wall.
25. The panel boards are to be fitted with suitable plastic drawing holders for the line diagrams, load schedule and panel as built drawings and bill of materials.
26. All cable and wire terminations, both incoming and outgoing of the functional units, including MCCB's, MCB's and other devices shall be through approved lugs. Functional unit assemblies shall suit the requirement.
27. The position of distribution boards is not to be hindered by any doors. In case of main panel boards the clear space in front of the board shall be 1.5 m and space at the rear and the sides shall be 750 mm minimum.
28. All access and installation arrangement shall be to the requirement of utility and their approval.
29. On completion of the installation, a rubber mat with anti-static properties (running the entire length 4-6mm thick and 1000 mm wide) shall be provided in front of all switchboards to the approval of utility.
30. Cable glands shall also be IP rated to suit the location. IP rating shall be maintained at the gland interface also by purpose made neoprene seal.
31. Install panelboards, cabinet boxes and enclosures including electrical connections, in accordance with the manufacturer's written instructions, applicable requirements of Local Standards Organization, BS and IEC and in accordance with recognized industry practices to ensure that products serve the intended function.
32. Co-ordinate installation of panelboards and enclosures with cable and raceway installation work.
33. Install only in permanently dry locations, away from all mechanical and public health services.
34. Anchor enclosure firmly to walls and structural surfaces, ensuring that they are permanently mechanically secured.
35. Check ratings of all circuit protection devices and other components according to approved material.
36. Provide electrical connections within enclosures.
37. Fill out panelboard's directory card upon completion of installation works.

3.02 FIELD QUALITY CONTROL

A. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's reports with submittals.

B. Routine Tests- The panel assembler shall perform the routine testing and provide the test certificates as defined in IEC 61439 standards. The routine test shall include but not limited to the following:

1. Inspection of the assembly including inspection of wiring and electrical operational test
2. Dielectric test & Insulation resistance test
3. Checking of protective measures and of the electrical continuity of the protective circuits
4. Test for all Circuit Breakers.
5. Functional tests as per approved test procedure.
8. Routine test certificates and test reports with all the readings shall be submitted to the MEPD Consulting Engineer for verification.

C. Inspect and test in accordance with BS 7671.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by BS 7671.

E. Test shunt trips, Communication/BMS interfaces to verify proper operation from remote.

F. Correct deficiencies and replace damaged or defective switchboards or associated components.

G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

H. Comply with Section 16910.

I. Prior to energization of circuiting, check all accessible connections to manufacturer's torque specifications.

J. Prior to energization of panelboard, check with earth resistance tester phase-to-phase and phase-to earth insulation resistance levels to ensure requirements are fulfilled.Migger test

K. Prior to energization, check panelboard for electrical continuity of circuits and for short circuits.

3.03 ADJUSTING

5. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
6. After wire and cable hook-ups and testing, energize panelboards and demonstrate functioning in accordance with the requirements. Check whether all outgoings are connected as per panelboard schedules. Record changes in the schedules for final as built, if acceptable to the Engineer.
7. Adjust alignment of switchboard covers and doors.

3.04 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard and associated devices.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's authorized representative.
4. Location: At project site.

3.05 PROTECTION

A. Protect installed switchboards from subsequent construction operations.

END OF SECTION

SECTION – 16510
INTERIOR LIGHTING

PART 1 GENERAL

1.01 Section includes

A. Interior Lighting including but not limited to, the following:

1. Recessed lights.
2. LED LAMPS AND FIITTINGS
3. Lighting fixtures accessories.

1.02 RELATED SECTSIONS

A.	Section 16050	Electrical Works, General.
B.	Section 16075	Electrical Identification.
C.	Section 16120	LV Cables and Wires.
D.	Section 16520	Exterior and Street Lighting.
E.	Section 16530	Emergency and Exit Lighting.
F.	Section 16910	Electrical Testing and Commissioning.

1.03 REFERENCES

A. CIBSE The Buildings Lighting Guides issued by the Chartered Institution of Building Services Engineers CIBSE - (UK)

B.	BS	British Standards
C.	IEC	International Electro - technical Commission.

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin.
3. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.
4. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
5. Technical performance of the equipment selected.
6. Dimensional details needed for installation and maintenance.
7. Copies of test reports or certificates.
8. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

C. Submit dimensioned shop drawings of lighting fixture installations, including but not necessary limited to, layout and connections to panelboards. Submit fixture shop drawings in booklet form with separate sheet for each proposed fixture, assembled in luminaire "type" alphabetical order.

1.05 QUALITY ASSURANCE

A. Manufacturer's: Firms regularly engaged in manufacture of lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years. Preference to be given to local manufacturer's and suppliers/agents.

B. All interior lighting fixtures shall be UL listed and comply with the requirements of BS, IEC and Local Standards Organization.

1.06 DELIVERY, STORAGE AND HANDLING

A. Luminaires, lamps, and accessories shall be delivered to the job site wrapped in protective covering and stored in a dry location free from dust or water, and in such a manner to permit easy access for inspection and handling. Luminaires, lamps, and accessories shall be handled carefully to prevent damage. Damaged items shall be replaced at no additional cost.

1.07 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials specified herein shall be of high quality and of proven suitability for the functions they will perform and the conditions they will meet in service.

B. <u>ALL LAMPS SHALL BE LED TYPE.</u>

2.02 Recessed LIGHTS

A. Furnish all light fittings complete with internal wiring, lamps and lamp holders, leads, trim, rings, frames, hangers and reflectors.

B. Lighting fittings shall be of sizes, types and ratings as shown on the Drawings and Schedules.

C. All wiring within the lighting fittings shall be suitable for the voltage, current and temperature to which insulation will be subjected.

2.03 PROTECTION CLASSIFICATION

A. All interior lighting fixtures' enclosures shall be classified in accordance with the IP classification system and two digit number code.

B. All interior lighting fixtures for outdoor use or in damp or wet locations, specially in bath rooms, shall be dust and damp proof and weatherproof as classification IP 44 minimum.

PART 3 EXECUTIOS

3.01 INSPECTION

A. Examine the areas and conditions in which the luminaires are to be installed and correct any unsatisfactory conditions detrimental to the proper timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

B. Coordinate light fixtures with the type of ceiling finish given in the ceiling finishes schedule.

C. Examine the architectural, mechanical and structural drawings to become familiar acquaint with the structural features of the building and the location of pipes, ducts, etc., which would alter the location or spacing of outlets. Submit to the Engineer for a decision as to the proper location. Be responsible for the proper reinforcement of any ductwork necessary to carry the added weight of lighting fixtures where same must be mounted on the bottom of such ductwork.

3.02 GENERAL INSTALLATION

A. Install lighting fixtures at locations as indicated in accordance with fixture manufacturer's written instructions, applicable requirements of C.I.B.S.E (U.K), and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Furnish all fixtures complete with lamps. Install permanent lighting fixtures after completion of all masonry and structural work do not use for lighting purposes during construction. Provide temporary lighting as herein before specified.

C. Where job conditions require mounting heights different from those specified or shown to avoid equipment or structural features, etc., such changes in mounting heights shall be as directed by the Engineer.

D. Set lighting fixtures plumb, square, level and in alignment. Secure in accordance with manufacturer's directions and approved shop drawings.

3.03 INTERNAL LUMINAIRES INSTALLATION

A. Luminaires shall be arranged for surface, recess or pendant mounting as required by the general structure and decor of the building. Where a suspended ceiling is provided, fix recess mounted luminaires as specified or as shown on the Drawings.

3.04 SURFACE MOUNTED LUMINAIRES INSTALLATION

A. All surface or pendant mounted luminaires shall be fixed to a surface or flush mounted metal conduit box. Direct surface mounted luminaires shall be spaced a distance of 12 mm from the mounting surface by using extension rings.

B. Make connections between the permanent wiring and the luminaire using cable rated for a minimum of 150 ^{o}C or more. Connect cable using a porcelain or heat resistant connector block housed in the conduit box.

3.05 RECESS MOUNTED LUMINAIRES INSTALLATION

A. Suspend all recess mounted luminaires independently of the ceiling in which they are fitted. Where such an arrangement is not possible or practical, the luminaires shall be fitted in and supported by the ceiling. Ensure that the suspended ceiling is suitably strengthened to carry the additional weight.

B. Make the connection between the permanent wiring and the luminaire using a heat resistant flexible cable connected to a 2 A, 3 pin "plug-in" type ceiling rose, conduit box mounted adjacent to the luminaire and accessible on removal of the luminaire.

C. The flexible cable shall be three core type, one core being used as the circuit protective and earth bonding conductor. Where the cable forms the connection to a tungsten lamp luminaire , it shall be rated for operation at 150 C minimum.

3.06 PENDANT MOUNTED INSTALLATION

A. Mount tube pendants from a ball and socket type swivel dome cover plate fitted to a ceiling mounted metal conduit box and conduit of minimum diameter 20 mm. The conduit entry to the luminaire shall be fitted with a lock nut and provide a flexible copper bond from the fixed conduit installation to the pendant tube.

B. Proprietary type pendant luminaires, whether single or multi-lamp units shall be bonded and provided with suitable terminations to ensure reliable earth continuity throughout all exposed metalwork.

C. Plain pendants shall consist of a multi-terminal ceiling rose, a flexible cord of heat resistant cable and a heat resistant lamp holder.

D. Do not suspended luminaires by means of flexible cables with the exception of certain lightweight domestic and commercial types of luminaires, which shall be agreed with the Engineer.

E. Support suspended luminaires by means of purpose manufactured metal supports.

F. Provide white break joint rings between the fittings and conduit box to mask the joints as deemed necessary by the Engineer.

3.07 ADJUSTMENT AND CLEANING

A. Clean interior lighting fixtures of dirt and debris upon completion of installation. Protect installed fixtures from damage during remainder of construction period.

3.08 FIELD QUALITY CONTROL

A. Comply with section 16910.

B. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

C. At the time of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after contractor's use and tested.

D. Test all luminaires functionally to prove that they operate satisfactorily.

E. Check and record actual illumination levels and compare them with the design requirements as per applicable standards.

3.09 EARTHING

A. Provide equipment earthing connections for all lighting fixtures in accordance with IEE.

B. Use separate earthing wire between fixtures and panelboard. Minimum size to be 2.5 mm^2.

END OF SECTION

SECTION – 16530
EMERGENCY AND EXIT LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Emergency and Exit Lighting units provided to facilitate orientation within, and escape from, buildings, upon failure of the normal lighting system.

B. Dependent on their location within the building, the emergency and exit lighting units will be powered either from Central Battery System or by standby generator set.

1.02 RELATED SECTIONS

A. Section 16050 Electrical Works, General.

B. Section 16075 Electrical Identification.

C. Section 16120 LV Cables and Wires.

D. Section 16510 Interior Lighting.

E. Section 16910 Electrical Testing and Commissioning.

1.03 REFERENCES

A. CIBSE The Buildings Lighting Guides issued by the Chartered Institution of Building Services Engineers CIBSE - (UK),

B. BS British Standards

C. IEC International Electro - technical Commission.

1.04 SUBMITTALS

A. Submit for complete and detailed manufacturer's catalogues and data relating which shall include, but not limited to, the following:

1. Name of the manufacturer.
2. Country of origin. Name and address of agents stating whether any manufacturing or fabrication is carried out in Jordan.
3. Method of obtaining spare parts for maintenance and list of spare parts sufficient for a 2 years period.
4. Technical performance of the equipment selected.
5. Dimensional details needed for installation and maintenance.
6. Copies of test reports or certificates.
7. Control schematics and wiring diagrams.

B. Provide samples of proposed devices together with the above submittal for approval of the Engineer.

1.05 QUALITY ASSURANCE

A. Manufacturer's: Firms regularly engaged in the manufacture of lighting fixtures and associated control gear of the types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 10 years. Preference shall to be given to local manufacturers and agents/suppliers.

B. All emergency and exit lighting fixtures and associated control gear shall comply with the requirements of BS,ICE and Local Standards Organization.

1.06 DELIVERY, STORAGE AND HANDLING

A. Pack equipment for protection during transportation and storage.

B. Store in dry, clean location.

1.07 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contract conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials specified herein to be of high quality and of proven suitability for the functions they will perform and the conditions they will meet in service.

2.02 GENERAL REQUIREMENTS

A. All emergency and exit lights and associated equipment shall be standard products supplied by a single manufacturer.

B. A LED to indicate "power supply" on shall be provided with each emergency and exit light fixture.

C. All emergency lighting units and illuminated exit signs shall have LED lamps, these shall be suitable to operate on 230 V or as shown on the Drawings.

2.03 EMERGENCY LIGHTING UNITS

A. Unless otherwise specified in the particular specifications. Lamps shall be LED type and shall operate in the emergency mode for a period not less than 3 hours.

B. All units shall have fire resisting diffusers, complying with the relevant standards and Codes of Practice mentioned elsewhere in this specification.

D. Type of emergency lighting to be used shall be as specified either in this Specification or as shown on the Drawings.

E. Every unit shall be connected to a permanently live supply of the local lighting circuit.

2.04 ILLUMINATED EXIT SIGNS

A. All illuminated exit signs shall be fireproof and provided in accordance with BS 5588 recommendations.

B. The housing of exit light fixtures shall be made of cold rolled sheet steel, baked enamel finish, with 3-4 W instant-on type LED and Arabic and English letters. The housing shall be surface or recessed type to suit the site conditions with color of the finish as required by the Engineer.

C. Where required for normal exits and emergency fire escape routes, the illuminated exit signs shall be provided with the sign plates comprising arrow to show the direction of the exit, as approved by the Engineer.

PART 3 EXECUTIONS

3.01 INSPECTION

A. Examine the areas and conditions in which the luminaires will be installed and correct or any unsatisfactory conditions before installation commences. Do not proceed with the work until conditions have been corrected to the satisfaction of the Engineer.

B. Examine the architectural, mechanical, and structural drawings and become familiar with the structural features of the building and the location of pipes, ducts, etc., which would alter the locations or spacing of outlets to the Engineer for a decision as to the proper location. This Contractor shall be responsible for the proper reinforcement of any ductwork necessary to carry the added weight of lighting fixtures where same must be mounted on the bottom of such ductwork.

3.02 INSTALLATION

A. Install emergency and exit lighting fixtures in accordance with the manufacturer's written instructions, applicable requirements of BS, ICE and Local Standards Organization and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Furnish all fixtures complete with lamps. Emergency lighting fixtures shall be installed after completion of all masonry and structural work and shall not be used for lighting purposes during construction.

C. Where job conditions require mounting heights different from those specified or shown to avoid equipment or structural features, etc., such changes in mounting heights shall be as directed by the Engineer.

D. Lighting fixtures shall be set plumb, square, level and in alignment and shall be secured in accordance with manufacturer's directions and approved shop drawings.

3.03 ADJUSTMENT AND CLEANING

A. Clean all lighting fixtures of dirt and debris upon completion of the installation.

B. Protect installed fixtures from damage during remainder of construction period.

3.04 FIELD QUALITY CONTROL

A. Comply with Section 16910.

B. Upon completion of installation of emergency lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

C. At the time of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's use and tested.

D. Test all emergency and exit lights functionally to prove that they operate satisfactorily for the intended purpose.

E. Check and record actual illumination levels and compare them with the design requirements, as per applicable standards.

3.05 EARTHING

A. Provide equipment earthing connections for all emergency and exit lights.

B. A separate earthing wire shall be used between any fixture and panelboard of minimum size 2.5 mm^2.

END OF SECTION

SECTION – 16690
COMPUTER NETWORK

PART 1 GENERAL

1.1 SUMMARY

A. Data Switches, Patch Panels, Fiber Cables, Giga-Speed UTP Cables, Data Outlets, University Passport and Cabinets.

1.7 REFERENCES

A. EIA/TIA 568 (Electronic Industries Association/Telecommunications Industries Association)- Commercial Building Telecommunication Wiring Standard.

B. EIA/TIA 569 (Electronic Industries Association/Telecommunications Industries Association)- Commercial Building Standard for Telecommunications Pathways and Spaces.

C. NETA ATS (International Electrical Testing Association) - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.8 SYSTEM DESCRIPTION

A. Backbone Pathway: Conform to EIA/TIA 569 using conduit and sleeves

B. Horizontal Pathway: Conform to EIA/TIA 569, using trunks.

C. Horizontal Wiring: By Owner. Complete from Branch switch to each outlet using unshielded twisted pair horizontal cables.

1.9 SUBMITTALS

A. Product Data: Submit catalog data for each termination device, cable, and outlet device.

B. Test Reports: Indicate procedures and results for specified field testing and inspection.

1.10 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations and sizes of cabinets and outlets.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in installing products specified in this section with minimum five years documented experience, and with service facilities within 100 miles of project.

C. Testing Agency: Company specializing in testing products specified in this section with minimum three years documented experience.

1.12 PRE-INSTALLATION MEETING

A. Convene minimum one week prior to commencing Work of this section.

PART 2 PRODUCTS

2.6 PATCH PANEL

A. Product Description: Cat 6e, EIA/TIA 568, rack-mounted assembly of terminals and accessory patch cords, with adequate capacity for active and spare circuits. RJ-45 modules, and Giga speed capability

2.7 COMPUTER OUTLET JACKS

A. Product Description: Conform to EIA/TIA 568 requirements for cable connectors forspecific cable types.

2.8 OPTICAL FIBER BACKBONE CABLE

A. Product Description: EIA/TIA 568, with 9/125 fiber type

B. 8 core fiber cable

C. Armored single mode fiber cable

D. Loose tube

2.9 UNSHIELDED UTP CABLE

A. Cat 6e, TIA 568 C.2, 100-ohm, unshielded twisted pair with 4 pairs,23AWG LSZH copper conductor.

2.10 DATA SWITCHES

A. MANAGE SWITCHS 48 POE+ PORT CAT6E WITH 4-SFP 10 G CISCO (C9300L-48P-4X-E)
B. MANAGE SWITCHS 24 POE+ PORT CAT6E WITH 4-SFP 10 G CISCO (C9300L-24P-4X-E)

2.11 CABINETS

Ready-made, metallic, key lock, Ventilated, mounted on wall, and racks inside. Refer to drawings to have details

2.12 DATA OUTLET

Wall mounted with RJ-45 module. Shuttered, and support Giga speed communication.

END OF SECTION

SECTION – 16710
FIRE ALARM SYSTEM &
MASS NOTIFICATION SYSTEM
(Siemens - Cerberus Modular Pro)

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fire alarm control panels, manual fire alarm stations, automatic Smoke and heat detectors, fire alarm signaling appliances, and auxiliary fire alarm Equipment and power and signal wire and cable.

1.2 REFERENCES

A. National Fire Protection Association:
1. NFPA 72 - National Fire Alarm Code.
2. Local Civil Defense Code.

1.3 SEQUANCE OF OPERATION

A. Fire Alarm System: NFPA 72, manual and automatic local fire alarm system Alarm Sequence of Operation: Actuation of initiating device causes the following

System operations:

1. Local fire alarm signaling devices sound and display with march time signal.
2. Location of alarm zone indicates on fire alarm control.
3. Signal transmits to building elevator control panel, initiating return to main floor or alternate floor and lockout for fire service.
4. Signal transmits to building mechanical controls, shutting down fans and operating dampers.
5. Signal transmits to release door hold-open devices.
6. Signal releases magnetic door hold opens.
7. Signal releases electric door locks
8. Drill Sequence of Operation: Manual drill function causes alarm mode sequence of operation.
9. Trouble Sequence of Operation: System or circuit trouble causes the following system operations:
10. Visual and audible trouble alarm indicates at fire alarm control panel.

B. Loops: As indicated on Drawings.

1.4 SUBMITTALS

A. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection; indicate annunciator layout, and design calculations.

B. Product Data: Submit catalog data showing electrical characteristics and connection requirements.

1.5 CLOSEOUT SUBMITTALS

1.6

A. Project Record Documents: Record actual locations of fire alarm equipment.

B. Operation and Maintenance Data: Submit manufacturer's standard operating and maintenance instructions.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 10years experience.

B. Design fire alarm under direct supervision of Professional Engineer experienced in design of this Work and Factory licensed.

1.8 MAINTENANCE SERVICE

Furnish service and maintenance of fire alarm equipment for one year from Date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Spare parts and maintenance products.
B. Furnish three of each typeof automatic smoke detector.

1.10 WARRANTY

A. Provide 12 months warranty where it starts from the date of handing over certificate in accordance with the contractconditions.

PART 2 PRODUCTS

- **All Devices & Components of the fire alarm & Mass notification systems shall be as approved by the APC (Siemens – Cerberus Modular Pro)**

- **Any required Devices & Components to complete the fire alarm and Mass notification systems and not mentioned in the BoQ, Drawings & Specifications shall be Supplied (From Siemens Cerberus Modular Pro) and installed without any variation or additional costs.**

PART 3.0 – EXECUTION

3.1 . All wiring within the system shall be carried out, in accordance with NFPA Class A Style 7 standards utilizing 2-core, 1.5mm, Fire resistant BS 6387 standards, with PVC jacket. Use 2X2.5 mm2 for voice evacuation system, 3 hr rating.
B. The cable for use on the Fire Alarm loop, Audio loop and the loudspeaker circuit shall be of the following type and specification. (One Kilo Metre per loop whereas audio loop may exceed 1 km)
1. The cable shall meet BS 6387 standard
2. The cable shall be of 2 cores
3. The maximum inter-core capacitance of the cable shall be: 0.5 microfarad.
4. The cable resistance shall be less than or equal to 13 ohms per core
5. Each core of cable shall be not less than 1.5 sq mm cross sectional area
6. The shall have an inherent or thorough metal conduit screen for earth continuity in order to produce electrical protection and screening
7. The cable shall have protection from heat and mechanical damage
8. Thee cable screen must be capable of being earthed at each system device (outstation)
9. The network cable (to interconnect the main fire alarm control panels) shall be of 3 cores of 1.5 sq mm cross-sectional area.

3.2. INSTALLATION:

A. Installation shall be in accordance with the NFPA 72 and , local codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 52 inches, nor more than 56 inches above the finished floor.

3.3. TYPICAL OPERATION:

A. Actuation of any manual station, smoke detector heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

1. Activate all programmed speaker circuits.
2. Actuate all strobe units until the panel is reset.
3. Light the associated indicators corresponding to active speaker circuits.
4. Release all magnetic door holders to doors to adjacent zones on the floor from that the alarm was initiated.
5. Return all elevators to the primary or alternate floor of egress.
6. A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.

7. Smoke detectors in the elevator machine room or top of hoistway shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.
8. Duct type smoke detectors shall, in addition to the above functions shut down the ventilation system or close associated control dampers as appropriate.
9. Activation of any sprinkler system low pressure switch or valve tamper switch shall cause a system supervisory alarm indication.

3.4. TEST:

Provide the service of a, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

END OF SECTION

SECTION 16729
IP VIDEO SURVEILLANCE SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes cameras, control equipment, and accessories.

1.2 SYSTEM DESCRIPTION

A. Description: Video surveillance and monitoring at points as indicated on Drawings.

B. Capacity:

1. Cameras: as shown on the drawings
2. Monitors: as shown on the drawings

C. Manufacturer - Integrator Qualifications:

- Bidders shall supply, install, configure, support, commissioning and training for CCTV System.
- Bidders must be a certified partner for Manufacturer (Avigilon) product in Jordan and should provide a new letter from the Mother Company to prove that and valid up to date.
- Bidders should be established at least 5 years ago in Jordan.
- Bidders shall submit a support letter from the manufacturer (Avigilon) dedicated for this particular project.
- Bidders must demonstrate they have technical expertise, resources availability, experiences, facilities, capabilities and financial resources necessary to perform the work in a satisfactory manner.
- Bidders shall submit a list of 10 similar executed projects in Jordan market for Manufacturer (Avigilon) products, at least with 100+ cameras for same brand .
- Bidder should have a trainee staff for Manufacturer (Avigilon) products and should approve that by provide certificates signed from the manufacturer.
- Bidders should have a local support office in Jordan.
- Bidders should have a local warehouse for spare parts stocking in Jordan.
- Fully integration on software level (seamless) with the Access Control System to easy event reporting and evidences.
- All the System Components must be manufactured-provided by the Same Vendor (NVRs / Servers, VMS, Cameras, Joystick, Analytics …)

1.3 SUBMITTALS

A. Shop Drawings: Indicate electrical characteristics and connection requirements, including system wiring diagram.

B. Product Data: Submit catalog data showing electrical characteristics and connection requirements for each component.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of cameras and routing of television cable.

B. Operation and Maintenance Data: Submit instructions for operating system and performing routine trouble shooting procedure.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum 5 years' experience.

B. Supplier: Authorized distributor of specified manufacturer with minimum 15 years' experience.

C. Installer: Authorized installer of specified manufacturer with service facilities.

1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of video surveillance system for one year from Date of Substantial Completion.

PART 2 PRODUCTS

- **As per specified cameras Brand, models & country of origin with all components, devices, licenses & software's needed**

PART 3 PART 3 EXECUTION

3.6 3.1 EXAMINATION

- Administrative Requirements: Coordination and project conditions.
- Verify surfaces to receive detection devices are ready for installation.

3.7 3.2 INSTALLATION

- A. Install Cat 6e inside conduit.
- B. Make conduit and wiring connections to door hardware devices.
- C. Install engraved plastic nameplates.
- D. Ground and bond intrusion detection equipment.

3.8 3.3 FIELD QUALITY CONTROL

- A. Quality Requirements: Testing and inspection services.
- B. Test in accordance with NFPA 72 and manufacturer's recommendations.

3.9 3.4 MANUFACTURER'S FIELD SERVICES

- A. Quality Requirements: Manufacturer's field services.
- B. Furnish services of technician to supervise installation, adjustments, final connections, system testing, and Owner training.

3.10 3.5 DEMONSTRATION AND TRAINING

- A. Furnish 10 hours of instruction each for two persons, to be conducted at project site with manufacturer's representative.

END OF SECTION

SECTION – 16910
ELECTRICAL TESTING AND COMMISSIONING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section compliments any other section in the Project Specifications relevant to Testing and Commissioning.

B. Testing and Commissioning of electrical systems and equipment.

C. Access shall be afforded at all times to the Engineer to enable him to inspect the Electrical Equipment.

1. Upon completion of the Electrical Equipment installation or part of the installation, the carry out and be responsible for testing and commissioning, in stages if required, to ensure that it is in proper working order and capable of performing all of its functions in accordance with the Specification and to the satisfaction of the Engineer. Any Electrical Equipment damaged in commissioning shall be replaced and retested by the Contractor at his own expense to the satisfaction of the Engineer.

2. All testing shall be carried out according to the requirements of the relevant standards and regulations as may be stated or implied in the Specification or otherwise agreed by the Engineer in writing.

3. Submit for Engineer's approval, no later than 6 weeks prior to the commencement of testing and commissioning, a schedule of all Electrical Equipment tests and commissioning procedures to be carried out to prove that the Electrical Equipment complies with the requirements of the Specification together with proposed program for such testing and commissioning.

4. Tests shall not commence before the schedule of tests has been approved and such other tests as may be required by the Engineer shall be included within the schedule of tests.

5. Give to the Engineer in writing at least ten days' notice of the date by which he will be ready to make the specified tests on completion of installation. Unless otherwise agreed the tests shall take place within seven days after the said date on such day or days as the Engineer shall in writing notify the Contractor.

6. The tests shall as far as possible be carried out under normal working conditions to the satisfaction of the Engineer and shall extend over such periods as he may direct.

7. Provide all skilled labor, supervision, consumables, apparatus and instruments required for commissioning and testing and within a reasonable time thereafter furnish to the Engineer a total of six certificates of all tests performed and accepted, signed by the Contractor, or an authorized person acting on his behalf, as prescribed in the appropriate regulations and specifications.

8. When any part of the Electrical Equipment fails to pass the specified tests, further tests shall be repeated, if required by the Engineer. The Contractor shall, without delay, put in hand such modifications as are necessary to meet the requirements as described in the Contract and any expense which the Owner may have incurred by reason of such further tests may be deducted from the Contract price.

9. Acceptance shall not in any way absolve the Contractor of his responsibility for the performance of the Electrical Equipment after erection as a complete working system in all respects.

10. Each completed system within the installation shall be tested as a whole under normal site operating conditions to ensure that each component functions correctly in conjunction with the rest of the system.

1.02 RELATED SECTIONS

D. Section16050 Electrical Works, GENERAL

PART 2 TESTING

2.01 GENERAL

A. Program, oversee, co-ordinate and record all the testing and commissioning of the electrical systems in co-ordination with those elements undertaken by the mechanical services Contractor. The electrical Contactor shall allow for liaising and attendance and providing all necessary test and general data information at the correct times.

B. For remote monitoring/controls, comply with the requirements as given in Section 15180.

C. The systems shall undergo phases of testing and commissioning, in accordance with the following:-

1. Phase 1. Works testing and quality assurance of elements;

2. Phase 2. Site installation, wiring, checks, performance and operational testsfor all elements;

3. Phase 3. Sub system group operational tests/performance tests;

4. Phase 4. Complete system operational and performance tests on dummy loads;

5. Phase 5. Complete system operational and performance tests on actual loads.

D. All the electrical systems, whether mentioned in this section or not, shall be subject to testing and commissioning.

E. All tests listed under the heading of "Field Quality Control" in various sections of Division-16 of these Specifications shall be conducted in the presence of and performed up to the full satisfaction of the Engineer. All the results/test reports shall be submitted in bound form for Engineer's approval.

2.02 ELECTRICAL TESTING

A. Tests of the installation shall be carried out in the following sequence:

1. Ring-main continuity.
2. Protective conductor continuity, including main and supplementary equipotential bonding.
3. Earth electrode resistance.
4. Measurement of insulation resistance including site built assemblies and distribution cables.
5. Check of protection by electrical separation, barriers and enclosures.
6. Measurement of the insulation on non-conducting floors and walls.
7. Check of phase rotation.
8. Verification of polarity.
9. Measurement of earth fault loop impedance.
10. Test of operation of residual current devices.
11. All external distribution cables, both high and low voltage in accordance with the relevant standard(s).
12. Fault simulation on protective devices or control system of stand-by generator, transformers, 11 kV cubicles, power distribution boards, motor control centers, etc.
13. Load test on standby generator, sub-station, power distribution boards, panelboards, etc.
14. All 11 kV cables and equipment shall be pressure tested. Submit a method statement for the test procedure, voltage levels and safety precautions.

2.03 LOW CURRENT SYSTEMS TESTING

A. All low current systems such as telephone, public address, fire detection and alarm, SMATV ….etc. shall be tested as specified herein or recommended by the manufacturers.

B. Submit to the Engineer in writing the procedure to test these systems as a whole for the site.

C. At the completion of these special systems installation for each facility, these shall be tested individually for each facility then it should be tested with their main control panel, such as fire detection and alarm, telephone etc. so that to see the good performance of these systems as a whole.

PART 3 COMMISSIONING

3.01 GENERAL

A. All Electrical Equipment and integral systems shall be commissioned in accordance with the relevant standards and regulations given in the Specification and to the recommendations of specialist suppliers (e.g. Switchboards, Fire Detection and Alarm System, Public Address System, Cables, etc.).

B. Full operational tests shall be carried out on all systems to demonstrate that they operate in accordance with the requirements of the Specification.

3.02 POWER DISTRIBUTION BOARD / PANELBOARDS

A. Design tests of:
- Rated continuous current.
- Short circuit current.
- Enclosure dielectric.

B. Production tests of:
- Dielectric.
- Mechanical operation.
- Grounding.
- Control wiring.
- Electrical operation.

3.03 FIRE DETECTION AND ALARM SYSTEM

A. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as Work progresses.

B. A systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on the logging form for readings, dates and witnesses. The Engineer shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the Engineer, shall be corrected.

C. Test reports shall be delivered to the Engineer as completed.

D. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing Contractor. The following equipment shall be a minimum for conducting the tests:

1. Ladders and scaffolds as required to access all installed equipment.
2. Multimeter for reading voltage, current and resistance.
3. Intelligent device programmer/tester.
4. Two way radios, flashlights, smoke generation devices and supplies.
5. Laptop computer with programming software for any required programme revision.
6. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
7. Decibel meter.

E. In addition to the testing specified to be performed by the installing Contractor, the installation shall be subject to test by the Engineer.

F. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the Contractor and submitted for review and approval to the Engineer in accordance with NFPA 72, and this specification. The Contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

G. A program matrix shall be prepared by the installing Contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input. In the case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; the complete output equation shall be referenced in the matrix.

H. A complete listing of all device labels for alphanumeric annunciator displays and logging printers shall be prepared by the installing Contractor prior to the ATP.

I. In conducting the ATP, the Engineer shall request demonstration of any or all input and output functions. The items tested shall include, but not be limited to, the following:

1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:

   a. Open, shorted and grounded intelligent analog or network signalling circuits.
   b. Open, shorted and grounded conventional zone circuits.
   c. Open, shorted and grounded speaker telephone circuits.
   d. Primary power or battery disconnected.
   e. Intelligent device removal.
   f. Incorrect device at address.
   g. Printer trouble, off line or out of paper.

2. System evacuation alarm indicating appliances shall be demonstrated as follows:

   a. All alarm notification appliances actuate as programmed.
   b. Audibility and visibility at required levels.

3. System indications shall be demonstrated as follows:

   a. Correct message display for each alarm input at the control panel, each remote alpha-numeric display and each CRT terminal.
   b. Correct annunciator light for each alarm input at each annunciator and colour graphic terminal as shown on the Drawings.
   c. Correct printer logging for all system activity.

4. System off-site reporting functions shall be demonstrated as follows:

   a. Correct zone transmitted for each alarm input.
   b. Trouble signals received for disconnect.

5. Secondary power capabilities shall be demonstrated as follows:

   a. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
   b. System primary power shall be restored for forty eight hours and system charging current shall be normal trickle charge for a fully charged battery bank.
   c. System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.

6. Fireman's HVAC override system functions shall be demonstrated as follows:
   a. Operation of key lockout switch preventing unauthorized operation of controls.
   b. On/Off controls of each controlled element and test of interaction of other automatic and manual control functions while in the over-ride mode.
   c. Correct status display of monitored elements.
   d. Correct logging of activity to printer and historical memory as programmed.

J. In the event of system failure to perform as specified and programmed during the ATP procedure, at the discretion of the Engineer, the test shall be terminated. The installing Contractor shall retest the system, correcting all deficiencies and providing test documentation to the Engineer. The Engineer may elect to require the complete ATP to be preformed again if, in his opinion, modifications to the system warrant complete retesting.

K. Changes made to a systems configuration program required by the acceptance inspector or to comply with the systems operating parameters shall be validated to insure that in making the software programming change no other part of the systems operation was effected. The validation shall utilize systems software which meets the requirements of NFPA 72 section 7-1.6 "System Reacceptance Testing" as specified in the NFPA 72 National Fire Alarm Code 1993 edition. Change validation methods other than that described will not be considered acceptable and shall allow the acceptance inspector to require the complete ATP to be performed again.

3.04 SAFETY TAGGING PROCEDURES

A. Develop and submit for Engineer’s approval prior to implementation, a safety tagging procedure for use when working on energized systems or to identify systems that have been turned over to operations.

B. Provide plastic tags of minimum dimensions 300 x 200 x 3 mm with appropriate internationally recognized pictorial symbols and statements in Arabic and English languages for use as safety tag. The tags shall be colored red with white letters or colored yellow with black letters as approved by the Engineer. The letters shall be at least 20 mm high or more as required. The safety tag shall be provided with fire resistant rope for suspension at suitable locations.

C. Type of safety tags shall include, but not limited to, the following:

1. Refer to the equipment instructions/manual for important information before proceeding.
2. This unit must be accessed only by qualified personnel.
3. Do not switch ON. Work is in progress on other end.
4. Danger – Hazardous AC (or DC) voltage.
5. Danger – AC mains voltage.
6. Danger – Hot surface. Do not touch without taking care.
7. Risk of injury due to high current.
8. Avoid contacting conductors with un-insulated metal objects. Follow safety precautions. Make sure the power is disconnected.
9. Danger – Arcing/Sparking may happen. Risk of eye injury. Always wear safety glasses.
10. Make sure the equipment is grounded before switching ON power.

D. The installation and removal of safety tagging shall be carried out with the permission of an Authorized Client's or Engineer's representative.

E. Approved type of pad locks shall be provided to lock out any circuit breaker, isolator, switch fuse or a piece of equipment to prevent accidental turn ON or turn OFF. The keys shall be in the custody of an authorized Owner's representative.

END OF SECTION

ELECTRICAL LIST OF APPROVED MANUFACTURERS

Material	Manufacturer	Origin Country
Final Distribution Boards	ABB	Germany
	Legrand	UAE/KSA
	Schneider Electric	KSA, UAE and Egypt
Molded Case Circuit Breakers (MCCB)	Schneider Electric (NSX, NS)	Europe
	ABB	Europe
	Legrand	Europe
Miniature Circuit Breakers (MCB)	Schneider Electric (Acti9 and Domae)	Europe, India, Thailand
	ABB	Europe
	Legrand	Europe
Residual Current Devices (RCD, RCCD, ELCB, RCBO)	Legrand	Europe/Turkey
	ABB	Europe
	Schneider Electric	Europe
Digital Meters	Schneider Electric (Power logic)	Europe
	Eaton	Europe
	Legrand	Europe
PDU Power Distribution Unit	Legrand	France
	MK	UK
PVC Conduits & Boxes	GEPICO	Jordan
	World Plastic	Jordan
	Rawand	Jordan
Galvanized Conduits & Boxes	Al Fanar	KSA
	GEPICO	Jordan
	Panasonic	Thailand
Power Cables & Wires.	Cableco	Jordan
	United Cables Industries Co	Jordan
	DUCAB	UAE
Cable Glands	BICC	UK
	CMP	UK
	HAWKE	UK
Hot Dip - Galvanized Cable Trays, Ladders & Trunks	Ardic	Turkey
	Al-Ashoury	KSA
	Legrand/Swift	UK
Wiring Devices	MK	UK
	Legrand	Italy
	Eaton/MEM	UK
Disconnect Switches	Hager Electro	France
	Baco	France

Material	Manufacturer	Origin Country
	Eaton	UK
Earthing & Lightning Protection Systems	Thermoweld	USA
	Furse	UK
	Wallis	UK
Indoor lighting Fixtures	Thorn	UK
	Trilux	Germany
	RZB	Germany
	Philips	Netherlands
	TEC-MAR	Italy
Outdoor lighting Fixtures	Bega	Germany
	Zumtobel	Germany
	IGuzzini	Italy
C. Exit Signs and Emergency	Eaton/Cooper	USA
	Orbik	UK
	Zumtobel	Germany
	RZB	Germany
Lighting Drivers	Tridonic	Austria
	TCI	Italy
	Vossloh-Schwabe	Germany
Fire Alarm & Mass Notification Systems	SIEMENS – CERBERUS PRO	USA
Fire Cables	Draka	UK
	Prysmian	UK
	Reka	Finland
Structure Cable System	AT&T	USA
	DATWYLER	SWITZERLAND
	3M	UK
CCTV System	Avigilon As Specified	Canada
Data Switches	CISCO – Models as Shown in Drawings & BoQ	USA
Data Cabinets	Smart Rack	USA
	Nordon	UK
	Legrand	Turkey / Europe

1- **THE BRAND & THE APPROVAL OF THE MANUFACTURER & COUNTRY OF ORIGIN DOES NOT RELEASE THE CONTRACTOR FROM FULL FILLING THE SPECIFICATIONS COMPLETELY; THE DEVIATION FROM SPECIFICATIONS WILL BE SUBJECTED TO ENGINEER SATISFACTION APPROVAL.**
2- **ALL THE ELECTRIC SYSTEMS ABOVE MUST BE SUPPLIED WITH A CERTIFICATE OF ORIGIN.**

HOLY ROCK
Consultant Engineers
الصخرة المشرفة
مهندسون مستشارون

WWW.HOLYROCK.COM

Project Name:RD&I Farm Building

Mechanical Specifications

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PLUMBING AND FIRE FIGHTING SPECIFICATIONS

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SECTION 10800

TOILET ACCESSORIES

PART 1: GENERAL

1.01 SCOPE OF WORK

A Furnish all labor, materials, equipment and incidentals required and deliver all toilet and shower accessories and as specified herein.

1.02 RELATED WORK

A Installation is included in Division 15.

1.03 SUBMITTALS

A Submit to the Engineer, complete shop drawings, manufacturer's catalog cuts and data sheets, complete parts list including gauge and type of material and all fasteners, installation requirements and construction details.

B Submit to the Engineer for approval, one representative sample of each item and model specified, if requested.

C Submit certificate of verification by an independent testing organization of grab bar strength and installation.

D Furnish at the time of delivery of materials, four complete sets of maintenance instructions.

1.04 DELIVERY, STORAGE AND HANDLING

A Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact. Store materials in unopened packages in a manner to prevent damage from the environment and construction operations. Handle in accordance with manufacturer's instructions.

PART 2: PRODUCTS

2.01 MATERIALS

Products specified inthis itemare products as manufactured by Bobrick Washroom Equipment, Inc. and are used only to determine quality, appearance, workmanship, gauge of metal, capacity and finish. Equal products by the approved list of manufacturers, will be acceptable, if, in the opinion of the Engineer, they meet the intent of this specification

as stated immediately above. Accessories furnished shall be the products of one manufacturer. Provide items complete with all screws, bolts and anchoring devices required for installation.

Surface-mounted hat and coat hook
Surface-mounted hat and coat hook shall be constructed of type-304 stainless steel with satinfinish and shall project 3-1/16" (80mm) from wall. Flange and support arm shall be 22-gauge (0.8mm) and equipped with a concealed, 16-gauge (1.6mm) mounting bracket that is secured to a concealed, 16-gauge (1.6mm) wall plate with a stainless steel setscrew. Hook shall be 12-gauge (2.8mm) and shall be welded to support arm.
Similar to Bobrick Model B-6827 or approved equal on quality and appearance, from the proposed manufacturer list only.

Surface-mounted automatic hand dryer
Surface-mounted hand dryer shall have a one-piece cast iron cover with white color vitreous enamel finish. Nozzle shall adjust for hand and face drying. Nozzle shall automatically return to hand drying position; and cannot be used as a vessel to hold liquids. International operating symbols shall be permanently fused into vitreous enamel cover. Motor shall be 1/10 hp, 6200 rpm, with automatic thermal overload switch. Centrifugal fan shall direct air flow through heating element at 150 cfm. Heating element shall be rated at 2300 watts, shall be located on inlet side of fan, shall heat air without hot spots, and be inaccessible to vandals. Electronic sensor shall automatically turn dryer on when hands or self-returning nozzle are held under the air-outlet opening and will shut off automatically when hands are removed or self-returning nozzle is released. Sensor shall shut off automatically after 90 seconds if an inanimate object is used to activate dryer and resets itself after inanimate object is removed. Unit shall be UL Listed, and or VDE approved, CE marked. Unit shall comply with EU Directive “Restriction of Hazardous Substance” (ROHS) requirements for non-use of certain hazardous substances in the production of electronic products. Unit shall be protected by a limited 10-year warranty on all parts except motor brushes. Motor brushes shall be warranted for a period of three years from date of purchase.
Similar to Bobrick Model B-700 (white), or approved equal on quality and appearance, from the proposed manufacturer list only.

Surface-mounted vertical soap dispenser
Surface-mounted soap dispenser shall be constructed of type-304 stainless steel with satin finish. Corrosion-resistant valve shall dispense commercially marketed all-purpose hand soaps. Valve shall be operable with one hand and with less than 5 pounds of force (22.2 N). Container shall be equipped with a, clear acrylic refill-indicator window; a locked, hinged stainless steel lid for top filling; and shall have a capacity of 40-fl oz (1.2-L). Unit shall have concealed, vandal-resistant mounting.
Similar to Bobrick Series Model B-2111 ,or approved equal on quality and appearance, from the proposed manufacturer list only.

Stainless steel grab bar
Stainless steel grab bar, 1-1/4" (32mm) diameter, with snap flange cover. Grab bar and concealed mounting plates shall be constructed of type-304 stainless steel with satin finish. Grab bar shall have wall thickness of 18-gauge (1.2mm) and outside diameter of 1-1/4" (32mm). Distance from inside of grab bar to finished wall shall be 1-1/2" (38mm). Flanges shall be 1/ 8" (3mm) thick stainless steel plate, 2" x 3-1/8" (79mm) in diameter, and each shall have two

screws holes. Flange covers shall be 22-gauge (0.8mm) and shall snap over mounting flanges to conceal mounting screws. Grab bar shall have 90º return to flange. Ends of grab bar shall pass through flanges and be heliarc welded to form one structural unit.
Similar to Bobrick Series B-5806x24 (600mm length) ,or approved equal on quality and appearance, from the proposed manufacturer list only.

Stainless steel swing-up grab bar
Stainless steel swing-up grab bar shall be constructed of type-304 stainless steel with satin finish (or satin finish with peened gripping surface; add .99 suffix to model number). Grab bar shall have wall thickness of 18-gauge (1.2mm) and outside diameter of 1-1/4" (32mm). Backplate shall be constructed of type-304 3/16" (5mm) thick stainless steel with satin finish with 4 countersunk holes for attachment to the wall. Swing-up grab bar shall be manually raised for approach or departure and lowered to horizontal position for support. Once bar is raised more than 45° from horizontal position, counterweighted design shall prevent bar from falling. Grab bar shall comply with ICC/ANSI A117.1-2003 Accessibility Standards in U. S. A.
Similar to Bobrick Model B-4998,or approved equal on quality and appearance, from the proposed manufacturer list only.

Single-roll toilet tissue dispenser
Single-roll toilet tissue dispenser shall be type-304 stainless steel with satin finish. Unit shall accommodate one standard-core toilet paper roll up to 5-1/2" (140mm) diameter (1800 sheets). Flanges and support arms shall be 22- gauge (0.8mm) and equipped with concealed, 16-gauge (1.6mm) mounting brackets that are secured to concealed, 16-gauge (1.6mm) wall plates with stainless steel setscrews. *Spindle shall be chrome-plated plastic with a heavy-duty internal spring. Manufacturer's service and parts manual shall be provided to the building owner/manager upon request.*To specify theft-resistant spindle as an optional accessory, add to specification: Theft-resistant spindle shall be removable only with special key provided.Single-Roll Toilet Tissue Dispenser shall be similar to BobrickModel B-6857or approved equal on quality and appearance, from the proposed manufacturer list only.

Surface-mounted waste receptacle.
surface-mounted fabricated of type-304 stainless steel with all-welded construction.Exposed surfaces shall have satin finishFront and sides of waste receptacle shall be one-piece, 22 gauge (0.8mm); back and bottom shall be one-piece, 26gauge (0.5mm).Top edge shall be hemmed and bottom of waste receptacle shall have recessed finger grip. Waste receptacle shall be equipped with four interior hooks, furnished with a removable heavy-gauge vinyl line. W355mm x H455mm. Minimum capacity: (24-L).Similar to Bobrick Model B-279,or approved equal on quality and appearance, from the proposed manufacturer list only.

Stainless steel channel frame mirror,
Mirror shall have a one-piece, type-430 stainless steel channel-frame, 1/2" x 1/2" x 3/8" (13 x 13 x 9.5mm), with 90º mitered corners; all exposed surfaces shall have bright polished finish. Mirror shall be No. 1 quality, 1/4" (6mm) float glass. Corners shall be protected by friction-absorbing filler strips and the back shall be protected by full-size, shock absorbing, water-resistant, nonabrasive, 3/16" (5mm) thick polyethylene padding. Galvanized steel back shall have integral horizontal hanging brackets located at top and bottom for mounting on concealed

rectangular wall hanger to prevent the mirror from pulling away from the wall. Locking devices secure mirror to concealed wall hanger. Mirror shall be removable from the wall.
Similar to Bobrick Series B-165**.** or approved equal on quality and appearance, from the proposed manufacturer list only.

PART 3: EXECUTION

3.01 INSTALLATION

A Installation is included in Division 15 but shall be performed as specified below.

B Coordinate rough opening size and location of masonry recesses with masonry work. Provide mason with rough opening dimensions.

C Use concealed fastenings where so designed.

D Attach accessories securely to walls and partitions in locations as shown or directed.

E Mounting height for accessories used shall conform to the applicable code.

F Where required, install concealed mounting devices and fasteners fabricated of the same material as the accessories, or of galvanized steel, as recommended by manufacturer.

G Elsewhere, install exposed mounting devices and fasteners finished to match the accessories.

H Provide theft-resistant fasteners for all accessory mountings.

I Secure toilet and shower accessories in accordance with the manufacturer's instructions for each item and each type of substrate construction.

END OF SECTION 010800

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SECTION: 15020

STANDARDS

1 INTRODUCTION

This General Specification indicates the minimum standard of Work, workmanship and materials necessary for the execution of the Contract to the approval of the Engineer and the true intent of this Specification and associated Drawings.

2 DESIGN STANDARDS

The installation shall conform to:

a) The general and specific requirements of the local water authority, public health officer, local drainage inspectorate and other local statutory authorities.

b) Local authority by laws and other regulations.

c) General and specific requirements of the local fire officer.

d) Relevant codes of practice of the British Standards Institution.

e) The requirements of the insurance companies concerned.

f) National Fire Protection Agency (NFPA)

g) American Society for Heating. Refrigeration, and air Conditioning specifications (ASHRAE).

h) The regulations for the electrical equipment of buildings, (current edition) published by the Institution of Electrical Engineers. London.

j) The recommendations of the manufacturers of all materials, plant and equipment.

i) Department of health and social security (U.K.), (D.H.S.S.) health building system engineering nucleus, Volumes 3 and 4C.

m) National Plumbing Code.

n) Hotel Operator-Architectural & Engineering Standards.

(Awarded contractor is to cross examine full compliance of all Technical Standards with IHC engineering standards. Contractor shall coordinate with site engineer for any deviations before erections).

3 SAFETY AND FIRE PRECAUTIONS

The Contractor shall ensure that safe methods of working are followed when using any equipment of materials which may involve a danger to life or to property and he is to take all necessary precautions to safeguard against damage by fire or explosion where the execution of the works may involve the presence of flame or sparks.

4 CONTRACTOR'S PLANT AND TOOLS

The Contractor, unless otherwise specified, shall provide all materials, tackles, slings, scaffolding, ladders, haulage, labor and apparatus necessary for the supply, delivery and erection of the plant on site.

The Contractor shall be responsible for providing at his own expense, all the requirements such as hand tools, hand lamps, and transformers, where necessary, to carry out the works including all cabling and intermediate connections from supply point to location of work. All wiring, cabling, etc., serving temporary installations are to be designed, installed and operated, as to be safe and in full accordance with the appropriate regulations.

As soon as any part of the Contractor's Site establishment or plant is no longer required for carrying out the Works, the Contractor shall disconnect and remove the same to the satisfaction of the Engineer.

5 PIPEWORK CONNECTIONS

The Contract shall include all pipework and connections to all sanitary fittings, basins and equipment as detailed on the Drawings and Architectural Loaded Drawings.

6 MATERIALS

All materials, plant and equipment shall comply fully with any relevant British Standard Specification or equivalent American standards.

The Engineer reserves the right to inspect materials, plant and equipment on Site at reasonable times and to reject any of the same not complying with the Specifications.

The cost of dismantling and re-erection of the installation occasioned by the removal of rejected materials, plant or equipment shall be borne by the Contractor.

7 STANDARDS

Corresponding parts of all apparatus shall be interchangeable and where mechanical or electrical details are used or which any part of parts are covered by a British Standard or American standards Specification, all such parts are to be made in accordance with such specification as shall be issued at the date at which the parts have been ordered.

Except where otherwise specified, all bolts nuts and stud screws thread shall be metric and all pipe threads to be to B.S. pipe threads standards.

8 TRADE CUSTOMS AND PRACTICE

The Contractor shall be entirely responsible for arranging and ensuring that the various classes of work comply with local trade customs and practice and shall provide accordingly in his Works.

9 DIMENSIONS

The Contractor shall take his own dimensions on Site for all plant and material to be supplied by him and shall be entirely responsible for the accuracy, of his measurements.

10 SETTING OUT

The Contractor shall set out the Works in accordance with his installation working drawings.

11 NAMEPLATES

All plant and apparatus supplied under this Contract shall be provided with brass nameplates, bearing the maker's name shop or reference number, size, type, test and working pressure, speed and other relevant particulars engraved thereon.

12 INTERRUPTION OF SERVICES

The Contractor shall not without permission of the Engineer interrupt or interfere with the operation of existing services such as water, electric lighting and power, buried cables, sewers, drains, etc., nor, in the case of works of statutory authorities or private owners, without the permission of these authorities or owners.

In the event of any such damage, the Contractor shall be responsible for the making good of same to the satisfaction of the Engineer, authorities or owners, as the case may be.

13 MISUSE OF MATERIALS

No materials brought on to Site for incorporation in the Works shall be used for scaffolding or any other temporary purpose.

14 VOUCHERS

The Contractor, at the request of the Engineer, must produce invoices, paid or unpaid, or accounts if required as proof that the goods are in all respect as herein specified.

15 OBSTRUCTIONS

No extra charge shall be made for moving or circumventing any obstruction or other Contractor's equipment that may be laid on the Site and the Contractor must, therefore, allow in his tender for these and any other contingencies likely to arise.

16 INSPECTION, TESTING AND REJECTION

The Employer representative and the Engineer with no extra cost shall be entitled during manufacture to inspect, examine and test the materials and workmanship for all plant to be supplied under the Contract, whether at the Contractor's or manufacturer's premises or on the Site. Such inspection, examination or testing shall not release the Contractor from any obligation under the Contract. The whole of the installation shall be tested on completion (in the presence of and to the satisfaction of the Engineer or his representative)

in the relevant Sections of this Specification as applied to the particular installation concerned.

Certificates of test, in duplicate, must be furnished by the Contractor to the Engineer, for all plant or materials specified to be tested at maker's works.

The tests on Site specified hereinafter are to be carried out in the presence of the Engineer or his Representative. The accuracy of all tests is to be to the satisfaction of the Engineer, whose decision shall be final.

The Contractor shall provide free of charge on the Site at his own expense and/or the manufacturer's works, such labor, materials, apparatus and instruments as the Engineer may consider requisite from time to time and as may reasonably be demanded to efficiently test the plant, materials or works as far as completed, until the plant is accepted as a whole by the Engineer. The Contractor shall at all times give facilities to the Engineer or his authorized representative to accomplish such testing.

The Contractor shall demonstrate, if required, the accuracy of any instrument used for testing.

At least seven days' notice must be given by the Contractor of any test carried out on the Site to enable the Engineer or his authorized representative to be present if they so desire.

Testing of pipes and other apparatus as specified under the various Sections of Specifications may be required to be carried out in parts against testing as a whole and the Contractor must provide accordingly in his tender.

Should the Works on testing not conform to the Specifications, the Contractors must make them so conform at his own expense and, if he fails to do so within a reasonable period, not exceeding fourteen days, the Engineer shall be at liberty to call upon him to remove the defective part and reinstate without cost to the Employer.

17 INSPECTION BEFORE CONCEALMENT

Whenever work subsequently to be concealed, requires inspection or testing due notice of at least seven days shall be given to the Engineer so that inspection may be made or tests witnessed before concealment.

Failure to give due notice may necessitate the Contractor uncover the work and re install it at his own expense.

18 VALVE LABELS

The Contractor shall supply and fix on all valves and stop cocks throughout the system, white ivorine labels with black engraved lettering to provide a clear indication of the precise function of the valve. Each label shall be numbered to agree with the Schedule of Valves and the 'As Fitted' drawings.

19 THERMAL INSULATION - GENERAL

All items of thermal insulation work covered by this Specification shall be carried out by skilled operatives in this field of work approved by the engineer.

The Contractor shall ensure that he is acquainted with all of the Conditions of the Works, specifications, hours of working, completion date(s), etc., at tender stage and he shall complete all Works within the program specified. The thermal insulation work shall not be commenced, unless otherwise approved in writing, until the whole or part of the installation has been completed and tested as set out in the relevant pipework, plant and air distribution Sections of the Specifications.

All thermal insulation shall be as detailed hereafter, unless specifically detailed otherwise under the relevant Clause of the Technical Specifications.

Thermal insulation shall conform to all relevant parts of the building regulations, and to BS 5422, 5970, and American standards.

Insulation materials shall comply with BS 3927 & BS 3958. Thermal insulation of the buried pipes services shall comply with BS 4508.

20 THERMAL INSULATION IN PLANT ROOMS

a) Pipework:

All pipework, as specified under item 2.19 shall be individually insulated with plain performed rigid glass fiber sections 64kg /m^3 density.

The sections shall be applied in 1,200 mm. lengths, cut longitudinally into halves and securely attached - to the pipework, without gaps, by self-adhesive circumferential bands at 300 mm. centers.

Whenever possible, the longitudinal seams shall be of an interlocking 2 type, to ensure a satisfactory joint.

Where the sections are cut and mitered around bends, branches, etc., they shall be fully taped to ensure they are held rigidly on to the pipe.

The thickness of insulation shall be in accordance with Appendix I at the end of this Section of the Specification.

All insulated pipework fittings and valves in all Plant Rooms, carpark, internally wet arias,roof and Tunnel shall then be enclosed in fabricated embossed aluminum cladding. The aluminum cladding shall be not less than 1.0 mm. thick on all pipe sizes.

Cladding shall be applied to bends and branch pipe connections prior to straight lengths as follows:

1) Bends on pipes up to 50 mm. dia. shall be clad by riveted 45° mitered joints.

2) Bends on pipes above 50 mm. dia. but below 100 mm. dia. shall be clad by riveted 3 segment lobster back bends.

3) Bends on pipes of 100 mm. dia. and above shall be clad by riveted 5 segment lobster back bends.

4) Branch pipe connections shall be clad by cutting a serrated edge opened out against the main pipe. A profiled hole to suit in branch pipe shall then be cut in the main pipe straight cladding.

5) Straight pipe cladding shall be rolled to suit the overall insulated pipe dia. and aluminum riveted at 100 mm. centers. The cladding shall be fitted tight to the insulation to ensure a rigid finish. Seams shall be positioned so as not to be generally visible.

All cladding terminations at valves etc., shall be fitted with aluminum end cappings.

b) Pipework Fittings:

All valves, flanges, unions, pump casings and other items requiring access for maintenance on DHW, Steam, and Condensate Pipework, shall be insulated and finished by means of removable 1.0 mm. thick embossed aluminum casings.

The casings shall be fully lined with rigid insulation of the same thickness as that applied to the pipe, securely fixed to the internal surfaces of the box.

The casings shall be split in two halves with one joint suitably hinged and the other securely fixed by quick release toggle fasteners. The casing edges shall be folded so as to give double thickness of aluminum on which to rivet the hinges and fasteners.

Heat bridges between the hot surface and aluminum casings will not be accepted.

Where thermostats, gauges, etc., are fitted the cladding shall be neatly cut and fitted with plain aluminum masking plates.

21 THERMAL INSULATION IN VOIDS SHAFTS AND DUCTS

Where pipes are installed in buildings voids, shafts and ducts and in any position otherwise indicated on the tender drawings, they shall be insulated as follows:

a) Pipework:

All pipework, shall be individually insulated with plain performed rigid glass fiber sections 64kg /m^3 density withaluminum foil Kraft laminate covering secured with an approved adhesive and circumferential joints sealed with tape, all to conform with Class '0' spread of flame.

Aluminum bands shall be applied to all insulation at approx. 300 mm. centers.

Where bends and offsets occur, the insulation shall be tailored to suit.

The thickness of insulation shall be in accordance with Appendix I at the end of this Section of the Specifications.

Polished aluminum and cappings shall be provided to close all insulation terminations.

b) Pipework Fittings:

All valves, flanges, unions and all other items requiring access for maintenance shall be insulated as follows:

1) DHW, Steam and Condensate Fittings on Pipework 40 mm. dia. and above:
Insulated with removable casings as detailed under Plant Rooms, adjoining insulation to be fitted with aluminum end caps.

2) All Other Fittings:
Adjoining pipe insulation to be fitted with aluminum end caps.

22 THERMAL INSULATION EXTERNALLY

Where pipes are installed externally on roof top plant rooms or in external underground trenches or in other wet areas internally, (i.e. showers, bath areas, etc.) and in any other positions otherwise shown on the tender drawings, they shall be insulated as follows:

a) Pipework:

All pipework, carrying hot or cold water and steam, shall be individually insulated with plain performed glass fib resections.

Self-adhesive tape bands shall be applied to all insulation at approx. 300 mm. centers.

Where bends and offsets occur, insulation shall be tailored to suit.

The thickness of insulation shall be in accordance with Appendix I at the end of this Section of the Specifications.

All insulated pipework shall then be covered with 0.8mm thick Polyiso-butylene (PIB) sheeting with 50 mm. overlaps on all circumferential and longitudinal joints. And shall be finally cladded with1.0mm aluminum cladding.

b) Pipework Fittings:

All valves, flanges, unions, etc., on all pipework carrying hot or cold water and steam shall be insulated as detailed in (a) above.

23 THERMAL INSULATION PROTECTION

Any pipework, which is insulated but which is likely to be accidentally damaged during maintenance or in gaining access to an area of void or at low level (constrained at 2 meter high from FFL)of plant rooms, shafts (Open in Tunnel) Tunnel and Roofs etc., shall be additionally protected with 1.0mm. thick aluminum sheeting. Any damage within the contract period, which may occur as a result of non-compliance with the requirements, shall be made good at no cost to the Employer.

24 PAINTING, GENERAL

All items of painting covered by this section of the Specifications shall be carried out by skilled Operatives in this field of work approved by the engineer.

The contractor shall ensure that the specialist painting contractor is acquainted with all the conditions of the work, specification, hours of working, completion date(s), etc., and he shall complete all Works within the program specified. The painting work shall not be commenced unless otherwise approved in writing, until the whole or part of the installation has been completed and tested as set out in the relevant pipework, plant and air distribution of the Specification.

All painting shall be as detailed hereafter, unless specifically detailed otherwise under the relevant Clause of the Technical Specification.

All painting materials shall be as manufactured by an approved manufacturer and shall be delivered in sealed containers, clearly labeled with type of material and intended use. The following surface treatments shall be applied to all areas detailed under this Section of the Specification unless stated elsewhere in the Specifications.

25 TYPES OF SURFACE TREATMENT

a) Method 1:
The surface shall be thoroughly wire brushed degreased and given one coat of primer as the installation proceeds.

b) Method 2:
The surface shall be hot dip galvanized in accordance with B.S.729. After installation, the surface shall be thoroughly degreased by solvent washing followed by one coat of undercoat/primer to suit the final coat of HIGH BUILD ALKYD Gloss to suit the Engineer's color scheme for the B.S.4800 range of colors.
Any damage caused to the galvanizing by burning or cutting shall have all weld splatter and swarf removed and patch primed prior to the paint system detailed above.

c) Method 3:
Shot blast all surfaces to SA 2.5 at manufacturer's works and within 4 hours (or before corrosion sets in, whichever is the sooner) apply one coat of Zinc Phosphate Primer 2-1-10 to 75 micron thickness and one coat of Micaceous Iron Oxide 2-4-01 to 60 micron thickness.

After installation apply one coat of Micaceous Iron Oxide 2-4-01 to 60 microns thickness, followed by one coat of High Build Alkyd Gloss to suit the Engineer's color scheme from the B.S.4800 range of colors.

d) Method 4:
The surface shall be shot blasted to SA 2.5 to give a minimal profile (maximum profile 50 microns) followed by one coat of HT Silicone Aluminum paint in the manufacturer's works.

Any damage to the treatment caused in transit or installation shall be made good.

e) Method 5:

The surface shall be wire brushed and degreased, painted one coat of primer as installation proceeds, followed by one coat of undercoat/primer to suit the final coat of High Build Alkyd Gloss to suit the Engineer's color scheme from the B.S.4800 range of colors.

f) Method 6:
The surface shall be painted with one coat of High Build, suitably thinned with thinners, followed by one coat of Spread Valve Undercoat to suit the final coat of High Build Alkyd Gloss to suit the Engineer's color scheme from the B.S.4800 range of colors.

26 PAINTING IN PLANT ROOM

a) All uninsulated pipework,flanges, unions, valves, trench covers and handrails shall be treated as Method 5.

b) All steel pipework to be insulated shall be treated as Method 1.

c) All pipe support to be galvanized shall be treated as Method 2.

d) Supporting steelwork for hoppers, gantries, hotwells, silos, tanks and all other structural steelwork shall be treated as Method 3.

e) All black steel hotwells, hoppers, silos, tanks and other fabricated mild steel equipment not detailed elsewhere shall be treated as Method 3 unless stated otherwise elsewhere in the Specifications.

f) All equipment and plant delivered to site in a prefinished condition shall have all damage made good prior to handover.

27 PAINTING IN VOIDS, SHAFTS AND DUCTS

a) All uninsulated pipework shall be treated as Method 5.

b) All steel pipework to be insulated shall be treated as Method l.

28 PAINTING EXTERNALLY

Painting externally shall be in accordance with that detailed for Plant Rooms with the following exceptions:

Where supports are installed in concealed positions, i.e. underground trenches and tunnels trenches etc, they shall be hot dip galvanized only.

29 PROTECTIVE PAINTING

Provide a heavy field coat of black asphalt paint on all steel pipe, cradles, vibration isolating mounts, and the like, that will be encased or partially encased in building construction, set in cement or fill, before items are built into the general construction. Kitchen range hood ducts and boiler breeching shall be painted with heat resistant paint.

Coat interior of each outdoor air chamber with two coats of odorless, rust resisting, nonscaling paint.
Coat interior of ducts at register boxes with two coats of black paint, to a dull finish.

All pumps, motors, and all other factory manufactured and assembled apparatus shall be factory coated with one coat of primer and one coat of machinery enamel, and after installation shall be cleaned and touched up to repair any damage incurred during construction.

30 MECHANICAL IDENTIFICATION

A. GENERAL

- Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

- Submit manufacturers catalog literature for each product required.

- Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

- Submit two tags, labels, pipe markers suitably sized for the project.

- Indicate installation instructions, special procedures, and installation.

- Record actual locations of tagged valves; include valve tag numbers to be part of Project Record Documents.

B. IDENTIFICATION MATERIALS SHALL BE AS FOLLOWS:

1. NAMEPLATES

Laminated three-layer plastic with engraved black letters on light contrasting background color.

2. TAGS

2.1 Plastic Tags:
Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 38 mm square

2.2 Metal Tags:
Brass with stamped letters; tag size minimum 38 mm square with finished edges.

2.3 Information Tags
Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 83 x 143 mm with grommet and self-locking nylon ties

2.4 Tag Chart:
Typewritten letter size list of applied tags and location in anodized aluminum frame.

3. STENCILS

3.1 Stencils: With clean cut symbols and letters of following size:
- Up to 51 mm Outside Diameter of Insulation or Pipe: 13 mm high letters.
- 64-150 mm Outside Diameter of Insulation or Pipe: 25-mm high letters.
- Over 150 mm Outside Diameter of Insulation or Pipe: 44 mm high letters.
- Ductwork and Equipment: 44 mm high letters.

3.2 Stencil Paint: As specified in Section 09900, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

4. PIPE MARKERS

4.1 Color and Lettering: Conform to ASME A13.1.

4.2 Plastic Pipe Markers:
Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

4.3 Plastic Tape Pipe Markers:
Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings

4.4 Plastic Underground Pipe Markers:
Bright colored continuously printed plastic ribbon tape, minimum 150 mm wide by 0.10 mm thick, manufactured for direct burial service.

5. CEILING TACKS

5.1 Steel with 19 mm diameter color-coded head.

5.2 Color code shall be green for plumbing valves

6. LABELS

Aluminum, size 48 x 19 mm, adhesive backed with printed identification and bar code.

7. LOCKOUT DEVICES

7.1 Lockout Hasps:
Anodized aluminum hasp with erasable label surface; size minimum 184 x 76 mm.

7.2 Valve Lockout Devices:
Steel device preventing access to valve operator, accepting lock shackle.

C. INSTALLATION

- Install identifying devices after completion of cleaning surfaces, coverings and painting.

- Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

- Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.

- Install tags using corrosion resistant chain. Number tags consecutively by location.

- Install underground plastic pipe markers 150 to 200 mm below finished grade, directly above buried pipe.

- Identifyboiler, pumps, tanks, and compresssors with plastic nameplates.

- Identify control panels and major control components outside panels with plastic nameplates.

- Identify valves in main and branch piping with tags.

- Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 20 mm diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

- Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

31 CLEANING

Due allowance shall be made for the full and proper protection of all items of plant and equipment, electrical installation and building structure during the whole of the application of the insulation and painting works.
Any damaged insulation/paintwork shall be replaced at no additional cost to the Employer.

32 INSTALLATION OF PIPED SERVICES

Installation of all pipework shall follow the detail set out in the accompanying drawings and be in accordance with the best accepted practice.

Details set out in the following Clauses of this Section are generally appropriate to all services except where specifically stated elsewhere in the Specifications and Drawings.

All exposed pipe runs shall be arranged to present a neat appearance and, where practical be parallel both with one another and with the building structure, taking due regard however to the grading, venting and draining requirements. All vertical pipes shall be plumb.

All exposed pipe runs shall be arranged so that the longest length of tube practicable is used between bends, tees and flanges or unions. Short lengths of tube joined together by sockets shall not be permitted.

All pipework, valves, fittings and equipment forming the piping installations shall be erected so that it can be dismantled and is accessible for repair and replacement. In this context, 'accessible' means that the provision for dismantling the flange, union, etc. can be reached and worked upon either in the open or else by removal of a purpose-made duct cover, manhole or similar cover; the fitting is "not accessible" if, as fixed, it cannot be manipulated.

Flange adapters and grooved coupling shall be provided at valves and equipment so that they can be dismantled. No pipe shall be installed without a flange adapter or grooved coupling at a point where it passes through a wall, floor or ceiling and is not readily removable.

No joints shall be formed within the thickness of walls. floors or ceilings.

To facilitate routine maintenance, the position of all valves, drains and supports shall be determined with this aspect in mind. Grouping of valves, drains, unions, flanges etc. shall be preferred to scattered sitting.

Clearance between pipework and finished walls, floors, ceiling and other fixtures should be adequate for cleaning purposes and future dismantling, and shall not be less than the distance given below:

Pipework to floor - minimum distance 100 mm.

Pipework to ceilings - minimum distance 100 mm.

Pipework to walls - minimum distance to conform with standard bracket centers

Pipework to pipework - minimum distance 32 mm.

The Contractor shall include for bends in pipes round piers and all other projections and recesses and for all offsets due to varying thickness of plaster, walls, floors, ceilings, and other structural works. It shall be the responsibility of the Contractor to ascertain the skirting heights, sill heights and floor finishes. No pipework offsets shall be allowed on pipework visible in rooms, except as agreed with the Engineer.

Where pipes are held in vices, as when screwing or cutting, care shall be taken to ensure that the pipe surface is not damaged. Any pipework so damaged shall not be fitted. Any pipework surface damaged by scoring whilst being installed, shall not be accepted.

The Contractor shall ensure that all pipes, fittings, valves, etc. are free from corrosion and internal obstruction. Pipes and fittings showing signs of corrosion shall not be fitted.
The Contractor shall protect the open ends of all pipework. Suitable caps, plugs or plastic covers only shall be used to cover open ends. Wood, rag or paper plugs shall not be used.

The Contractor shall not use a valve fitted to the open ends of a disconnected pipe to prevent the entry of dirt.

Failure to comply with the above instructions shall mean that the Engineer shall have the right to order the pipework to be dismantled for as far as considered necessary and the pipework to be thoroughly cleaned internally.

The Contractor shall carry out this work free of cost to the Employer and shall bear all costs incurred by removing, cleaning and replacing the sections of pipework.

Pipework shall be erected to neatly follow the lines of walls, floors, tunnels and trenches and be correctly graded to ensure venting and draining down can be achieved. Manual valved air vent lines shall be installed at all high points. The clearance between pipework (or if lagged, the lagging) and walls, floors or any other fixtures shall be not less than 100 mm. Pipe drops shall be vertically plum. All horizontal and vertical adjacent pipework shall be installed parallel to walls and floors except where gradients for venting and draining dictate otherwise.

Headers, where indicated shall be arranged so that each circuit isolating valve is connected direct to a vertical outlet on the top of the header. Circuit connections such as thermometers, flushing valves and circuit isolating valves shall be arranged at common horizontal levels.

Distribution headers up to and including 50 mm. installed on closed circuit recirculation systems shall have the ends terminated with a screwed cap or plug.

Distribution headers above 50 mm. on closed circuits and on open circuits shall have the ends terminated with a grooved end caps onto the pipe, and a blank flange bolted to it.

Curved or long sweep bends and branches shall be provided as far as is practicable. Square elbows will not be permitted.

Wherever practicable, made bend and sets shall be furnished in preference to short radius fittings. Bends and sets in black pipework above 50 mm. diameter shall be hot formed having a radius not less than four times the pipe diameter. The tubes must remain circular after setting.
Long sweep branches with gradual reductions shall be used for reduced diameters where two mains connect together.

Exceptions to the above shall be used where air pipes or air bottles, drain or dirt pockets, are taken off or air venting requirements dictate, in which case square connections and fittings may be used.

Special care shall be taken where branch joints, welded joints, basses, vents and drain pockets are made, to ensure that there is no obstruction or possible cause of obstruction and to see that full bore is maintained in all directions.

1- All branch connections shall be taken from top, side or at a 45° angle from all horizontal piping. Bottom connection shall not be allowed without special flushing provisions being made. When taking side connections from horizontal mains adequate facilities for draining shall be provided.

2- The distance between any two adjacent branches shall not less than the sum of the outside diameters of the branches.

Reduction in sizes of pipe lines shall be made by reducing mechanical coupling.

33 PIPEWORK MATERIALS

All pipework installed by the Contractor shall conform with the specified materials, specified under the relevant sections and BOQ items.

34 MILD STEEL PIPEWORK

Where the table of pipework materials requires the use of mild steel pipework, black or galvanized, this shall be straight, cleanly finished, round in cross section, free from cracks, surface flaws, lamination and other defects and shall be free from rust and scale.

Steel Pipe Wall Thickness

Nominal Pipe Size	Wall Thickness (MM)	Nominal Pipe Size	Wall Thickness (MM)
(MM)	Sch. 40	(MM)	Sch. 40
15	2.77	100	6.02
20	2.87	150	7.11
25	3.38	200	8.18
32	3.55	250	9.27
40	3.68	300	10.31
50	3.91	350	11.10
65	5.15	400	12.70
80	5.49	450	14.27

Steel pipes, which are to be used 'black', shall be varnished externally throughout their length after manufacturer.

Where steel pipes are to be installed underground, they shall be double wrapped in special tape and nylon suitable for the application.

35 COPPER PIPEWORK

Where the table of pipework materials requires the use of copper pipework, this shall be solid drawn from phosphorous deoxidized non-arsenical copper to free from any deleterious film. Copper Pipework used shall be in accordance with ASTM standards type "L"

All piping and tubing used in the installation described in this Specification shall be straight, cleanly finished, round in cross section, free from cracks, surface flaws, laminations and other defects.

36 CPVC PIPE WORK

CPVC pipes and fittings shall be provided for all cold, hot water and return hot water pipes running on the roof , carparks, in the risers, from the ground tank and at high level inside the building above false ceilings and where ever shown in the drawings .

CPVC pipes and fittings shall be provided also for all condensate pipes.

The CPVC pipes and fittings shall be from the same manufacture.

Date of manufacturing for pipe and fittings shall not be more than two years of date of the submittal

The CPVC pipes shall pass the tests from the Royal Scientific Societety Labs , a random samples from the site will be taken for tests , all expenses for the tests shall be upon contractor responsibility and will be paid directly from him .

Pipes pressure shall be 25 bar for cold & hot water pipes, pipe pressure shall be 16 bar for condensate pipes.

All CPVC pipes and fittings which are exposed to the sun and inside car parks shall be insulated by closed cell expanded rubber 12mm thick, density 65-80kg/m^3. Insulation shall be chemical and oil resistant, self extinguishing, and shall withstand a temperature ranging from 40°C to 120°C, and shall be protected by smooth aluminum cladding of 1mm thickness; the insulation and aluminum cladding shall be included in the prices of CPVC the pipes in the B.O.Q.

A primer for CPVC pipes and fittings, shall be used before using CPVC solvent.

All sizes for CPVC pipes, fittings and expansion joints shown on the drawing and B.O.Q are according to Din standards or ISO 15877 Standard .

37 Sanitary Distribution Pipework

The sanitary pipework for cold water and hot water distribution from the water distribution main domestic cold and hot water cpvc pipes above false ceilings to the sanitary fixtures shall be cross linked polyethylene plastic pipes, Pex/a or Pex/c, and manufactured to DIN 16892/3 with a working temperature of 95°C at 10 bar, and 20°C at 20 bar, and shall comply with and approved by DVGW (Germany).

The outside diameter of all pipes supply sanitary fixtures shall be as mentioned on drawings.

The pipes shall run in conduits (sleeves) to each individual outlet without using any fittings along to the sanitary fixtures

The sleeves shall be of smooth polyethylene pipe of 32mm dia for 16mm and 20mm pipes.

The pipes shall be flexible type delivered coiled.

The gap between the conduit and the pipe connected to the manifold outlet shall be sealed with approved rubber ring.

The connections of PEX pipes to the tapes, mixers etc., shall be made using brass elbow/adapter, housed in PVC box (Termination Box) built inside the wall. The boxes shall have provision for incoming flexible conduit.

The termination box shall have compression connection for PEX pipe on one side and female thread for the sanitary fixtures on other side .

The complete assembly shall be such that the PEX pipe can be withdrawn and replaced without damaging the wall finish , a brass crome plated ball valve shall be installed between the main domestic cold and hot cpvc pipes and each cross linked polyethylene plastic pipe branch .

38 JOINTING OF MILD STEEL PIPEWORK

Black mild steel pipework up to and including 50 mm dia. shall be jointed by screwing joints.

Black mild steel pipework of 65mm. dia. and above shall be jointed by mechanical grooved joints.

All galvanized steel pipework shall be screwed or jointed by mechanical grooved joints, same as black steel pipes.

All mechanical grooved joints shall be fastened by flexible mechanical couplings; except for fire fighting pipework they shall be rigid coupling.

All screwed black steel pipework shall have provision made for dismantling, using unions.

Galvanized mild steel pipework up to and including 50mm. dia. shall have provision made for dismantling using galvanized malleable iron unions.

Galvanized mild steel pipework of 65- mm. dia. and above shall have provision made for dismantling using galvanized mechanical couplings.

39 JOINTING OF COPPER PIPEWORK

Copper pipework up to and including 40mm. dia. shall be jointed using capillary silver brazing fittings.

Copper pipework above 40mm dia. shall be jointed using led free bronze grooved mechanical couplings and fittings according to ASTM (B-584).

During all jointing operations the fitter/plumber shall be accompanied by a competent assistant and suitable asbestos mats shall be used to protect the building fabric and decorations.

Every precaution shall be taken to prevent damage by scorching or fire, and the Contractor shall provide the fitters/plumbers with two portable fire extinguishers for use in an emergency.

40 MECHANICAL COUPLINGS

All pipe of suitable of wall thickness for sizes above 65mm for mildsteel pipes and 40mm for copper pipes may be jointed by using of mechanical wall grooved pipe and coupling on services with working temperatures not to exceed 85ºC. This shall include the following building service piping systems:-

Fire Protection

- Fire Standpipe - Wet and Dry
- Automatic Sprinklers - Wet
- Water Supply (domestic hot and cold copper pipes)

Installation shall be operative trained by the manufacturer.

Mechanical coupling shall be used for all grooved pipes, valves, fittings and other grooved component.

All grooved joints shall be jointed by mechanical rigid or flexible couplings.

Couplings shall be of cast ductile iron confirming to ASTM A-536 and shall be UL listed and FM approved for fire fighting pipework and shall be bronze confirming to ASTM (B-584) for domestic cold and hot pipework.

The joints shall be self-centering and comprise coupling pieces, sealing gaskets, special nuts and bolts.

Grooves shall be formed at the end of the pipe by machine to manufacturer's instructions. Grooves shall be dimensionally compatible with the coupling

Joints shall made to the manufacturer fitting constructions. Earthing continuity clips shall be fitted at every point.

41 SCREWED JOINTS

Screwed joints shall be tapered to B.S.21, or to ANSI B1.20.1.

Steel pipes having screwed joints shall be carefully reamed out before the plain end is screwed.

When making a joint, the screw thread shall be coated with a white jointing compound to B.S.5292 and good quality hemp, all surplus jointing compound being finally cleaned off to leave a surface suitable for painting. P.T.F.E. tape may only be used with the prior agreement of the Engineer.

The joint shall be arranged so that on completion two or three threads are left showing.

Should a screwed joint prove defective under subsequent test, caulking shall not be allowed.

42 WELDED JOINTS (FOR STEAM PIPEWORK)

Steel pipes, having welded joints on the run, shall be prepared for jointing in a manner suitable for the technique employed. Welding shall be carried out in accordance with R.S.2971 for metal arc welded joints, using covered electrodes and B.S.1821:1957 and B.S.2640:1955 for oxy-acetylene welded joints.

Pipes shall be prepared for welding with ends swan or cut off by hand, flame cut by hand with subsequent truing up by filing or by grinding to a bevel of 37.5" as may be required. Welding rods shall in all cases be of good quality copper coated low carbon steel and the manufacturer shall provide test certificates representative of the rods in accordance with B.S.1453: 1972. Group A.

All pipework shall be reamed after cutting to ensure it is free from rust, burns, scale and other defects and shall be thoroughly cleaned before erection.

All welded joints, produced by the oxy-acetylene flame process, shall be of best quality, the butt being slightly convex with regular ripples and no undercutting, washing away or surface cavities being resent. Notches at the root indicating incomplete penetration and excessive weld protruding into the pipe bore in

excess of 1.5 mm. shall not occur and the external reinforcement shall run out smoothly to the pipe surface on either side.

Welding shall in all cases be carried out by skilled craftsmen, who are in possession of a current certificate of competency issued by an approved authority (which shall be produced at the request of the Engineer and have had a suitable period of experience for the class of work in which they are engaged in accordance with B.5.4871 and B.S.4870.

Highly skilled non-certificated welders may only be used by written permission of the Engineer and test welds, in accordance with R.S.4870, Part l, 1972 with satisfactory laboratory test certificates, shall be submitted before this permission is granted. The Engineer shall determine a suitable independent testing authority and any costs arising from these tests shall be borne by the Contractor.

During all welding or cutting operations, the welder shall be accompanied by a competent assistant and suitable asbestos mats shall be used to protect the building fabric and decorations.

Every precaution shall be taken to prevent damage by scorching or fire, and the Contractor shall provide the welder with two portable fire extinguishers for use in an emergency.
After cutting or welding, all flashings shall be removed from all pipework before erection.
All welded joints shall be painted two coats of red oxide on completion of the joint.

43 FLANGED JOINTS

Flanges on black mild steel pipes shall be of flange adapter suitable for mechanical grooved system.

Flanges on galvanized mild steel pipes shall be of the galvanized flange adapter suitable for mechanical grooved system.

Flanges on capper pipes shall be of copper flange adopters and suitable for mechanical groove system

44 FITTINGS FOR STEEL PIPEWORK

Fittings for all mild steel pipework up to and including 50 mm. dia. shall be malleable cast iron pipe fittings to B.S.143, or ANSI B16.3, with the exception of steam pipework on which wrought steel pipe fittings, manufactured from mild steel by seamless or welded process to B.S.1740 shall be used.

Fittings on galvanized pipework shall be galvanized to B.S.729, Part 1.

The screwed ends of the fittings shall be provided with parallel female and tapered male threads to B.S.21, Part 1, the axis of thread being coincident with the true axis of the fittings. Where required, taper threaded fittings shall be provided and shall be in accordance with B.S.143.

Fittings on black mild steel pipework of 65mm. dia. and above shall be grooved end fittings and shall be UL approved and FM listed.

In addition to the fittings set out in the standards, branch bends manufactured to the same details may be used.

Ends of fittings, which shall have the same wall thickness as that of tube shall be beveled for butt-welding where welding joints used.

Generally all fittings shall, where practicable, be of the easy sweep type. Branches shall be made using swept tees or branch bends except where an air lock is liable to form i.e. tees on rising mains, etc., where square tees shall be used.

Elbows shall be used only where the use of bends is impracticable and where the Engineer's permission has been obtained.

Where standard fittings are not available for the duty required, reductions on the run and to the branch shall, in all cases, be made with reducing sockets not bushes.

Reducing fittings on horizontal pipework shall be of the eccentric pattern fixed so as to give a smooth run to the crown of the pipe. Concentric pattern reducers shall be used on vertical pipework.

The diameter shall be maintained; crinkled and scored work will not be accepted.

Where junctions to steel mains are formed by factory or site welding, such work shall be carried out to the above standards for steel tubular. All necessary reinforcement by way of plates, collars or shoes shall be provided. All branch bends, where possible, shall be formed by the use of special welding fittings of the same quality as the pipe and shall conform to B.S.1965:1963 and amendments.

Where branch bends are used, the profile of the hole shall be carefully set out to match the fitting and where the holes are flame-cut all loose scale and oxide shall be removed from the main before the branch is welded into position.

The distance between the centers of two adjacent branch welds shall not be less than twice the diameter of the large branch. All changes in direction shall be proportioned so that the ratio between the center line radius of the bend and the inside diameter of the pipe is not less than 1.5: 1.

Lobster back and cut and shut bends will not be permitted.

Unions shall, in all instances, be manufactured with double gunmetal seats.

45 FITTINGS FOR COPPER PIPEWORK

Capillary fittings shall be to ASTM standard suitable for type "L" pipes. All fittings shall be manufactured from materials being non-dezincificable, i.e. copper or gunmetal.

Silver brazing fittings shall be manufactured from copper according to ASTM standards.

All fittings shall be suitable for the working conditions of the system and purpose-made fittings shall be used throughout. All branch connections shall be by purpose made tees, either square or sweep, to suit the application.

Where practical, fittings shall be of the long sweep pattern. Where standard fittings are not available for the duty and sizes required, reductions shall be made with purpose-made fittings.

In all cases, tubes shall be loaded prior to bending with springs, low melting point alloys or an inert sand, care being taken that contamination of the tube material is avoided.

No pulled bends with any deformity whatsoever resulting in the forming of the bend shall be permitted.

Unions shall be manufactured from gunmetal and shall be according to ASTM standards. For sizes above 40mm grooved end copper or gunmetal fittings shall be used.

46 FITTINGS FOR CPVC PIPEWORK

All fittings used onCPVCpipework shall be made from CPVCfrom the same pipe manufacturer and according to the same standards of the CPVC pipesand shall have a working pressure of 25 Bar.CPVC jointing shall be as the manufacturer recommendations.

47 SUPPORT SYSTEM

1. Mechanical Supports & Duct hangers.
2. Thermal expansion –Sliding Elements.
3. Riser Pipes.
4. Passive Fire Prevention System.
5. Tables

1 MECHANICAL SUPPORTS AND HANGERS

1.1 All installation material used for supporting and fixing Mechanical Pipe systems should be of a modern type that gives tested reliable supporting solution without the need for welding, drilling or subsequent galvanizing for corrosion protection.

1.2 The Mechanical Installation system should consist of the following components:

1.2.1 C-Channels should be used as the main item for supporting all pipes. C-Channels should be made of rolled steel strip as per DIN standard. The steel is Sendzimir Galvanized to a thickness of 20 microns. Contractor must submit mechanical drawing showing all support locations combined with detailed load calculation. Where the channel is cut, suitable end caps should be used to protect the cut from corrosion. C-Channels of minimum thickness of 2mm and width of 40mm shall be used all applications, and the height to be selected according to load calculation.

1.2.2 C-Channel accessories as recommended by the channel manufacturer, should be used to assemble various channel structures as appropriate for the application. These accessories

include single-part components for attaching connectors, fixing nuts with serration, angles, brackets and pipe ring saddles. All galvanized.

1.2.3 Pipe Ring Clamps: For hot, cold domestic pipes; galvanized, pre-engineered pipe ring clamps should be used for fixing all pipes to channel system or directly to the correct structure. The contractor should verify that the pipe supported weight does not exceed the recommended maximum load of the clamp as provided by manufacturer. The pipe rings should be of a double screw type. Medium duty pipe rings shall be used for pipes up to 3 inch size and heavy duty pipe rings shall be used for sizes 4 inch and above except for the fire fighting system, the vertical pipes shall be supported by heavy duty double screw pipe rings without rubber and shall UL listed, all pipe rings used for copper pipes and hot-chilled water steel pipes should be provided with a pre-fitted rubber inlay;

1.2.3.1 Rubber inlay: made of EPDM material inspected for sound insulation as per DIN 4109, temperature resistance from(-40 to +110) ◌̊C.

1.3 Threaded Rods used should be manufactured as per DIN standards of steel Grade 4.6, The Threaded rods, nuts and flat washers used should have a clean thread and flawless galvanized condition.

1.4 Concrete anchors: should be internally threaded for fixing rods, made of galvanized zinc plated and passivated steel. Anchor should have FM, VDS and fire resistance approval.Zinc plated and passivated steel bolt anchor with suitable diameter should be used for fixing channels into concrete.

2 THERMAL EXPANSION SLIDING ELEMENTS

Hot water ,steam pipes are subjected to thermal expansion due that sliding gliders or saddles should be used to prevent a build-up forces at the pipe clamp and the fixing points, the glider /saddle should provides a sufficient slid way distance according to the manufacturer load limit and movement limit.

3 RISER PIPES

Special fabricated steel arms should be used to be supported on slap as cantilever and to be welded on pipe sides to hold the riser pipe weight for details see support drawing.

4 PASSIVE FREE PREVENTION SYSTEM

4.1 All openings through walls, ceilings and floors due to penetrations of mechanical installation as well as those due to construction joints, should be sealed with fire rated products suitable for the specific application as specific application as specified here under.

4.2 The product shall be capable of stopping the passage of fire, air and water through wall, floor and ceiling penetrations, cladding, and

expansion joints. The product shall exhibit the minimum designed fire resistant properties.

4.3 The products shall be obtained from an approved, established, and proven firm and quantities shall be applied strictly in accordance with the written instructions of the manufacturer and to the approval of the engineer.

4.4 The recommended treatments for application shall be as follows:

4.4.1 Metal pipe and duct crossings: the annular space around the pipe shall be packed with fire rated from backing material and the ends shall be filled and sealed with fire rated elastic sealant according to manufacturer data. The size of the circular opening shall be maintained as the barest minimum as recommended by the sealant manufacturer.

4.4.2 Non-metal pipe and conduit crossings less than 50mm in diameter: The annular space around the pipe shall be packed with fire rated from as backing material. The ends should then be filled and sealed with, fire rated sealant.

The circular opening shall be maintained strictly minimum recommended by sealant manufacturer.

Pipes/Conduit shall be wrapped and applied strictly according to the manufacturer's specifications.

5 ALL PIPE AND DUCT SUPPORT SPACING SHOULD BE INSTALLED AS FOLLOWS:

5.1 Support galvanized threaded steel piping as follows:

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	HORIZANTAL PIPES (m)
Galvanized steel Threaded	15 – 25	8mm	1.2
	32	8mm	1.6
	40 – 50	8mm	1.9
	65– 108	10mm	2.2
	125	10-12mm	2.5
	150	10-12mm	2.6

5.2 Support black steel seamless sch 40 piping as follows:

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	HORIZANTAL PIPES (m)
Black steel seamless Welded	15	8mm	1.6
	20 – 32	8mm	2.0
	40 – 65	8mm	2.7
	80	10mm	4.5

	100	10mm	5
	125 – 150	10-12mm	6
	200 – 300	12-16mm	7

5.3 Support Copper pipes as follows:

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	HORIZANTAL PIPES (m)
Copper	8 -12	8mm	1.0
	15 - 20	8mm	1.3
	25 - 40	8mm	1.7
	50	8mm	2.2
	65 - 80	10mm	3.3
	100	10-12mm	4.0

5.4 SupportPE pipes as recommended by manufacturer.

5.5 Support PP-RCT pipes as recommend by manufacturer.

5.6 Support PVC pipes as follows:

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	HORIZANTAL PIPES (m)
PVC	40	8mm	0.6
	50	8mm	0.7
	75	10mm	0.8
	100	10mm	1.0
	150	10-12mm	1.2

* Spacing between pipe supports may be decreased as per the manufacturer of the pipe supports recommendation.

48 EXPANSION AND CONTRACTION OF PIPEWORK

Expansion and Contraction of Pipework, expansion joints, guides, and anchor points, as required, whether or not shown on the drawing shall be installed at structure expansion joints and where required to resist the maximum stresses of the pipework, formed by the Contractor.

a) Expansion Joints

Expansion joints shall be of the straight bellows type and of axial pattern or as otherwise indicated. They shall be provided with screwed union or flanged or grooved ends as appropriate to facilitate replacement unless otherwise approved. They shall incorporate internal liners if required and shall be manufactured from 18/8 stainless steel and shall be designed to withstand the test pressure of the system. Bellows shall be capable of not less than 2,000 complete cycles of movement over the designed working range without failure. Pipework supports shall be arranged as near as possible to the joints.

Expansion joints shall be selected to accommodate the maximum working temperature and temperature range of the systems. Rods or hangers shall be provided to take imposed end thrusts.

Joints up to 38 mm. shall have screwed ends to B.S.P. and 50 mm. and upwards flanged ends to B.S.10/4504. All compensators shall be installed in accordance with the manufacturer's recommendations.

All expansion joints shall be provided with external protection where exposed to damage. For axial joints this shall comprise an external sleeve. Joints shall be installed so that they are not subjected to stresses other than those for which they are designed. Unless otherwise indicated they shall be installed so that they are in their free position at a temperature midway between the high and low limits of normal service.

All connections between bellows and pipework shall be aligned prior to and during welding by means of welding clamps.

Axial joints shall be installed in line with the axis of the pipe and shall not be subjected to any tension during installation other than that approved by the manufacturers.

Flanged joints shall be pulled up diagonally across the flanges by means of long bolts after the joints are made the long bolts shall be removed diagonally one at a time and replaced with standard bolts, nuts and washers.

Joints with flanged ends shall be installed during the erection of pipework if possible. Otherwise, temporary distance places of accurate dimensions shall be provided. Each such distance piece shall be exactly equal to the "installed" length of the compensators and shall have flanges precisely square with the pipe and flange bolt holes of the compensator. All expansion joints shall be securely locked in position prior to and during hydraulic testing. Should joints be unable to withstand test pressures they shall be isolated from the piping systems.

Axial expansion joints shall be cold drawn during installation to an agreed amount not exceeding the manufacturer's recommendations.

When installing expansion joints, the manufacturer's installation recommendation shall be observed in every respect.

When pressure testing pipework distribution mains, the Contractor shall ensure that the test pressure will not damage the bellows, where the test pressure exceeds the maximum operating pressure.

All cleats, brackets and steel work required for building-in shall be supplied by the Contractor, unless stated otherwise elsewhere in the Specifications.

Details of all anchors shall be submitted to the Engineer for approval before manufacture.

The bellows shall be installed with due allowance having been made for cold draw, which will vary according to the type and length of bellows proposed and the temperature of installation. Where "installation bars" or fittings are incorporated with the bellows during delivery and erection, these must be removed before heat is applied.

Care shall be taken when installing flanged end bellows to line up the bolt holes on joint and mating flanges and to ensure that the joint is not twisted in any way or any torsional stress applied.

b) Guides

Free guide sleeves shall be fitted on each side of the expansion joint, unless such joint be installed adjacent to an anchor point when guides shall be fitted on the free side only.

Guides shall consist of a tube of diameter not more than 3 mm. greater than the outside diameter of the main and length four and a half times the diameter of the main with a minimum length of 300 mm. unless an alternative design is shown on the Tender Drawings.

Guides shall be installed not more than one and a half pipe diameter from the expansion joint to the first tubular guide and not more than 15-20 pipe diameters between this guide and the next pipe support.

Further pipe guides shall be provided along each pipeline at intervals equivalent to not more than 75 pipe diameters and where shown on the Drawings.

The Contractor shall provide all necessary pipe guides to prevent long pipe spans from buckling and to ensure alignment and linear free movement of pipes from anchor points towards expansion joints constructed to prevent transverse movement and carefully installed so that axial movement is not hampered. Means for lubrication shall be provided where necessary.

Each pipe guide on sections of pipework incorporating axial joints shall be of the tube type with rods tack welded to the guide, and arranged to locate and restrain the pipe in all planes.

Special supports and fixing accessories shall be provided at all heavy items of pipeline equipment i.e. valves, etc. to ensure that no undue strain is placed upon the pipeline at their incidence.

After fabrication, all ferrous fixings and supports shall be thoroughly wire brushed to remove dirt, scale, rust etc. and then given two coats of red oxide primer prior to bolting to or building into the building structure.

Detailed drawings of pipe guides and supporting frames shall be submitted to the Engineer for written approval prior to manufacture.

49 GRADING OF PIPEWORK

All pipework shall be installed with continuous grading to allow for drainage and/or air venting according to the service concerned. Gradients shall be generally as follows for the various services.

- Heating Branches: l in 250 Condensate 1 in 125/250

			Steam	1 in 250
-	DHWS and all CWS:	1 in 750	Comp. Air	1 in 125
-	Gas:	1 in 250		

50 AIR VENTING OF SYSTEM

Full provision shall be made by the Contractor for air venting of the system at all high points in pipework formed by the Contractor, whether or not shown on the drawings.

Automatic air vents shall be used where indicated on the Tender Drawings and where necessary and shall have gunmetal bodies with not less than 15 mm. connection copper or stainless steel floats, guides and non-corrodible needle valves. In all cases, the air vent shall be preceded by a lock shield pattern stop valve and a strainer and the discharge from the air vent shall be 10 mm. copper pipe, which shall discharge to outside in a position which shall be agreed in advance with the Engineer.

The automatic air vents shall in all ways be suitable for the pressure and temperature of the system on which they are to be installed.

Pipework shall be arranged as to allow air to be vented out of the system through air handling units, fan coil units, etc. Also at high points, an air bottle with needle valve shall be installed.

Air bottles in pipework up to and including 80 mm. bore shall be manufactured from 50mm bore pipe, 100 mm. bore and over from 100 mm. bore pipe. All bottles shall be 250 mm. long with welded end caps and be complete with 8 mm. bore copper pipe brought down from the top of the air bottle to within reach of ground or floor level and fitted with 8 mm. lock shield needle valve complete with key.

Where required by the Engineer, air bottle vents shall be brought to false ceiling level and shall terminate with an 8 mm. (0.25" BSP) manual air vent projecting neatly through the ceiling.

On MPHW/HPHW systems the discharge pipe and needle valve shall in all ways be suitable for the pressure and temperature of the system on which they are to be installed and shall be arranged discharge to a safe place.

All exposed air bottles, automatic vents and drip pipes where required shall be properly insulated.

51 DRAINING OF SYSTEM

Drain points shall be provided by the Contractor at all accessible low points of water services installations and also on the branch side of all main isolating valves and cocks whether shown or not on the Drawings.

Drain points shall be fitted with a lock shield drain cock of gunmetal construction manufactured to the requirements of B.S.2879; 1980, type 'A', complete with hose union and removable key. The base of the pocket shall be drilled and tapped to accept a 15 mm. lever operated plug cock of suitable design.

Drain points on MPHW/HPHW systems shall be fitted with a bronze needle valve with plugged outlet.

52 PIPE SLEEVES

In all cases where pipes pass through walls, floors, ceilings and footings, which are not fire rated, the Contractor shall provide sleeves which shall be built in and shall be responsible for ensuring that this is performed correctly. Sleeves shall in no case be used as pipe supports, a free annular space always being provided. Puddle flanges shall be provided on pipework passing through walls and trenches intended to be covered by earth, etc., or where passing through bund walls. Sleeves shall be of pipe cuttings properly reamed, cleaned and trimmed at 90° to bore.

Sleeves in non-load bearing walls, floors ceiling and partitions shall be copper or mild steel to suit the particular pipe materials.

Sleeves shall be provided with an inside diameter of not less than 25 mm. larger than the insulated outside diameter of the pipes. Pipes passing through load bearing walls or footings shall be provided with proprietary 'CSD' type pressure tight bulkhead seals suitable for up to a maximum differential water pressures of 138 Kg/m2 or alternatively, puddle flanged cast iron sleeves shall be provided with an internal diameter 100 mm. larger than the outside of the pipe. The space between the pipe and sleeve shall be sealed with a water tight mastic or silicon rubber compound. Gland plates not less than 6 mm. thick shall be fitted if necessary to withstand water pressures. Details of all sleeving arrangements through liquid - tight walls shall be submitted for approval.

Where pipes pass through fire barriers proved proprietary approved fire rated type mechanical seals shall be provided or alternatively steel sleeves shall be installed with the space between the sleeves and pipework sealed with suitable fire rated material.

External flashing sleeves shall be provided by the Contractor except where indicated otherwise. They shall incorporate an integral flange to which a flashing shield can be clamped or welded. The Contractor shall build the shield into the membrane and fill the space between the sleeves and pipe with waterproof materials or mastic compound.

For pipes, which change direction, oversized sleeves, the size larger than normal shall be fitted to allow for expansion. The space between the pipe enclosed and its sleeve shall be caulked with suitable filling material to be approved by the Engineer

Sleeves shall not protrude from the finished face of` walls. In toilets, kitchens and all other situation where the floor may be swilled, the sleeve shall project 30 mm. above the finished floor level.

53 FLOORPLATES

Where exposed to view, pipes and tubing passing through walls, floors, ceilings, partitions and false ceilings of occupied rooms shall be fitted with a heavy chromium- plated die cast zinc alloy masking plate. Such plates shall be split on the diameter, be a snug fit to the pipe concerned and provided with countersunk holes for set screws.

54 PRESSURE GAUGES, THERMOMETERS AND AUTOMATIC AIR VENTS

A. Pressure gauges

The pressure gauge shall be 100mm dial size made of stainless steel casing filled with glycerin with 6mm dia bottom connection threaded to BS21, scale 0-12 bar. The dial shall be made of aluminum. The bound on tube shall be made of brass.

Accuracy shall be either according to American standard ASME B 40.1 Grade 1B, or European standard EN 837.

Stainless ball valve shall be installed with the pressure gauge size 6mm dia class PN-20.

B. Thermometers

200mm diameter with aluminum finished casing with anti scratch hard powder coat finish. The lens shal be standard clean shatter proof polycarbonate or double strength glass, the scale shall be in ^{o}C,(10 - 50^{o}C) and F,(0 - 120F) and shall be made of aluminum with white finish and black marking. The stem shall be made of aluminum fitted in stainless steel separable socket. Accuracy shall be ±1 of the scale division.

C. Automatic air vent

Shall be fitted with 15mm ball valve. The vent shall be made of brass rated for 10 bar working pressure and 110^{o}C maximum working temperature.

55 VALVES

General:

The brand name of the manufacturer of all valves striners and check valves shall be casted on the body.

1. Domestic Cold and Hot Water Services

A. Isolating Valves ≤ 50mm shall be:-

Threaded bronze or DZR body extended stem ball valve of min PN 20 bar.

B. Isolating Valves ≥ 65m shall be:-

Grooved bronze body butterfly of min PN 20 bar and shall have lever lock / infinitely variable with memory stop for size up to 110mm and gear operated for size larger then 110mm.

C. Non Return Valves ≤ 50mm shall be:-

Threaded bronze or DZR body swing pattern or piston spring , PN 25.

D. Non Return Valves ≥ 65mm shall be:-

Grooved and spring assisted single disk for horizontal and vertical installations, ductile iron body with enemal coating, PN 20 bar.

E. Strainers ≤ 50mm shall be:-

Threaded bronze or DZR body fited with stainless steel perforated strainer element having maximum 0.8mm holes with serewed cap, PN 25 bar.

F. Strainers ≥ 65mm shall be:-
Grooved end bronze body wye type, PN 20 bar

G. Fixted or Variable orifice double regulating valves ≤ 50mm :-
Threaded bronze or DZR body with momery stop lock, PN 20 bar.

H. Variable orifice double regulating valves ≥ 65mm shall be :-
Grooved non ferrous copper alloy body, bonnet, core and spindle, EPDM seat, PN16 bar. From the same manufacturer of ≤ 50mm sizes.

I. Draining Taps ≤ 25mm shall be:-
Bronze angle pattern screw-down draining tap, lockshield type. Male inlet threaed to BS 21 tapper, outlet ribbed to provide integral hose connection. Rated PN 10

2. Compressed Air

A. Isolating Valves ≤50mm shall be:-
Nickel plated brass end entry Ball Valve threaded BS21 taper. Quarter-turn lever operated. Chrome plated Brass Ball. Virgin PTFE seats, blowout proof stem. Gas board tested and certified. Rated PN20.

B. Isolating Valves ≥ 65mm shall be:-
Fully lugged cast iron bodied butterfly valve fitted with Nitrile liner, 316 stainless steel disk and stem. Trigger lever operated with thermal break to prevent transfer of heat to the lever. To fit between PN16 flanges. Maximum temperature 90°C. Rated PN16.

C. Strainers ≤ 50mm shall be:-
Bronze 'Y' type Strainer. Ends threaded to BS 21 taper. Fitted with perforated stainless steel screens with 0.75 mm holes. Machined seats body and cap ends. Screwed-in cap with captive washer. Rated PN20.

D. Strainers ≥ 65mm shall be:-
Cast Iron 'Y' type Strainer. Ends flanged to BS 4504 PN16. Fitted with perforated stainless steel screens with 0.75 mm

holes. Machined seats body and cap ends. Bolted cap with captive washer and drain plug. Rated PN16.

E. Relief Valves ≤ 80mm shall be:-
Bronze Angle Pattern Relief Valve threaded connections to BS 21 fitted with top cover, lever and padlock with 360-rotation facility. Bronze or gunmetal diskwith PTFE insert. Stainless steelsprings.

F. Draining Taps ≤ 50mm shall be:-
Bronze Angle Pattern Screw-down Draining Tap, lockshield type. Male inlet threaded to BS 21 taper, outlet ribbed to provide integral hose connection. Washer EP rubber. Rated PN10.

3 Oil

A. Isolating Valves ≤ 50mm shall be:-
Bronze Gate Valve to BS 5154 Series B threaded to BS 21 taper. Solid wedge disk, non-rising stem, screwed-in bonnet, hand wheel operated. Rated PN20.

B. Isolating Valves ≥ 65mm shall be:-
Cast Iron Gate Valve to BS 5163 flanged BS 4504 PN16. Wedge disk. Bronze seat rings and disk facings. Rated PN16.

C. Non Return Valves ≤ 50mm shall be:-
Bronze Non-return Valve swing type to BS 5154 series 'B' threaded to BS 21 taper. Renewable nitrile rubber disk, free to rotate, and hinge pin mounted. Screwed-in cap. Integral seat. Rated PN25 but limited to 90°C maximum temperature.

D. Non Return Valves ≥ 65mm shall be:-
Cast Iron Non-return Valve swing type to BS 5153 flanged BS 4504 PN16. Bronze faced disk, free to rotate, hinge pin mounted. Bolted cap. Body seat ring bronze. Rated PN16.

E. Strainers ≤ 50mm shall be:-
Bronze 'Y' type Strainer. Ends threaded to BS 21 taper. Fitted with perforated stainless steel screens with 0.75 mm holes. Machined seats body and cap ends. Screwed-in cap with captive washer. Rated PN20

F. Strainers ≥ 65mm shall be:-
Cast Iron 'Y' type Strainer. Ends flanged to BS 4504 PN16. Fitted with perforated stainless steel screens with 0.75 mm holes. Machined seats body and cap ends. Bolted cap with captive washer. Rated PN16.

56 ACOUSTIC STANDARDS FOR MECHANICAL INSTALLATIONS

Vibration Isolation Specifications

1.00 General specifications

A. All mechanical and electrical equipment, piping as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. All piping located in mechanical equipment rooms, and for a minimum of 50 feet (15.0 m), whichever is greater, from any connection to vibration isolated mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration isolation hangers.

C. All isolators shall provide the required static deflection indicated in Appendix II at the end of this section.

D. It is the supplier's responsibility to ensure that all isolators offered to the contract meet the specifications and are suitable for the load, operating and environmental conditions, which prevail.

E. A single manufacturer shall provide all vibration isolation materials specified herein in order to assure single source responsibility for the proper performance of the materials used.

F. The contractor shall submit samples of specified isolation devices upon request to the engineer for approval.

G. The contractor shall have prepared by the isolation materials manufacturer or his representative, and shall submit to the engineer for approval, drawings showing the construction of the isolation devices to be used, including specific selection of the isolators for the equipment to be furnished for this project.

H. The drawing shall include the complete design of supplementary bases; a tabulation of the design data for each isolator. Including spring OD, free operating, and solid heights, and ratio of horizontal to vertical stiffness, and other required data to clearly indicate that the specified isolator types and minimum static deflections are provided by the system submitted.

I. Installation of all vibration isolation materials specified shall be accomplished following the manufacturers written instructions. Installation instruction shall be submitted to the engineer for approval prior to beginning the work.

J. The contractor shall submit a complete set of approved shop drawings of all mechanical and electrical equipment to receive vibration isolation devices to the vibration isolation manufacturer or his representative. The shop drawings furnished shall include operating weights of the equipment to be isolated and the distribution of load at support points.

2.00 Isolator Types and Specifications:

2.01 Floor mounted Equipment

A. Type 1. **(Precompressed fiberglass or neoprene pads)**

1. Pads shall have provisions to be fixed to supported and to supporting structures.

2. Pads shall be resistant to lubricating oil, water, and chemicals likely to be present in the plant room or external area.

3. Pads shall have a minimum rarted static deflection of 0.4 inch (10 mm).

B. Type 2. **(Seismic Isolator Incorporated Within A Steel Housing)**

1. Spring isolators shall be lateral restrained spring isolators, incorporating a single coil spring element, having all of the characteristics of free standing coil spring isolators as previously specified. Springs shall be assembled into a welded steelhousing engineered to limit lateral movement of supported equipment during an earthquake without degrading the vibration isolation capabilities of the spring during normal operating conditions.

2. Vibration isolators shall incorporate a steel angle and plate motion limiting assembly and steel coil spring, designed as a system to accept a force in any lateral direction in excess of the design seismic requirement for the isolator without yield orfailure. Isolator shall limit lateral movement of the equipment to less than 1/4" (6 mm) in any direction. The lateral limit stop shall incorporate a neoprene grommet to prevent the potential for metal-to-metal contact. The vibration isolation element shall include a 1/4" (6 mm) thick ribbed neoprene noise stop pad, positioned outside of the housing anchorage path. The housing shall incorporate drilled holes for attachment to the supporting structure. Similar to model FYS as manufactured by kinetics noise control or approved equal.

2.02 Ceiling suspended Equipment

A. Type 3. **(combination Spring& neoprene Hangers)**

1. Vibration Hangers consisting of unhoused steel springs in series with a molded neoprene insert assembled into a stamped or welded hanger bracket. Hangers shall incorporate a high deflection, color coded spring element and neoprene isolator complete with load plate.

2. Spring shall be epoxy powder coated with 1000 hr salt spray rating per ASTM B-117. Spring shall be color coded or otherwise identified to indicate load capacity. The spring element shall have a minimum lateral stiffness of 1.0 times the rated vertical stiffness.

3. Hanger brackets shall be designed to carry a 500% overload without failure and to allow support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.

4. The combination isolation hanger assembly with neoprene insert shall be model SRH, as manufactured by kinetics noise control or approved equal.

B. Type 4. **(Fiberglass & neoprene Hangers)**

1. Vibration Hangers consisting of fiberglass or molded neoprene insert assembled into a stamped or welded hanger bracket. Hangers shall be complete with load plate.
2. Hanger brackets shall be designed to carry a 500% overload without failure and to allow support rod misalignment through a 30° arc without metal-to-metal contact or other short circuit.
3. The isolation hanger assembly with fiberglass or neoprene insert shall be model FH or RH, as manufactured by kinetics noise control or approved equal.

Type 5. Seismic Restraint for Ceiling suspended equipment

1. Seismically restrain all suspended equipment above 300LB wt. Use Type J aircraft Cable Restraints for all piping supported by vibration isolation hanger assemblies.
2. Type J cable seismic restraint sizes, quantities, locations, and mounting details shall be as per ASHRAE and or SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition

2.03 Inertia Bases

A. Type A. (Concrete Inertia Base)

1. Inertia bases shall be constructed from reinforced concrete and shall be designed for the stressing due to the weight of supported machine. The surface shall be steel float finished or equivalent and leveled to the machine manufacturers requirements. Machinery shall be fixed to the base with ‘grouted-in’ holding down bolts located in reverse tapered caste sockets.

2. Where the inertia base will be supported on spring in shear mountings, the base shall be formed with prefabricated mild steel

continuous edge frame, 13 mm diameter reinforcing bars on nominal 200 mm centers each way. The mountings shall be fixed to brackets, which are welded to the sides of the edge frame.

3. The design of the brackets and mountings shall allow the base to be raised from (or lowered onto) the floor by adjustment of the leveling bolts between mountings and brackets. The design shall also allow the insertion (or removal) of the mountings when the base is resting on the floor.

4. Thickness of the base shall be a minimum of 8% of the longest span between isolators, at least 150 mm. Where inertia bases are used to mount pumps, the bases shall be large enough to support piping elbows.

5. Concrete inertia bases shall have a clearance of 50mm between the housekeeping pad and base.

B. Type B. (Steel Beam Base)

1. Bases shall be structural beam sections, with welded isolator support brackets and percolated and drilled anchor bolts holes, and shall be designed by the isolation materials manufacturer.

2. Beam section shall not be structurally connected to each other. Minimum section depth of each member shall be equal to 8% of the longest span between supporting isolators, or as shown on the drawings or indicated on the project document.

3. Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mountings height for the supported equipment.

4. Steel bases shall have a 25mm clearance between housekeeping pad and base.

3.00 Acoustical Floating Floor System

1. Mechanical equipment bases for (Chillers, Air handling units, pumps, boilers and generators) located on the roof, adjacent to noise sensitive areas or on levels -between floors- shall be acoustically treated by installing propreitary floating floor system.

2. Floating Floor system primarily control airborne sound transmission, they shall not be used in place of vibration isolators and inertia bases.

3. The isolation material supporting the floating slab must be resilient, have permanent dynamic and static properties and safely support both the floating slab and the imposed live load for the life of the building.

4. Isolation material for the floating slab should:

a) Have constant natural frequency in the range of 10-15 Hz.

b) Be resistant to oil, water, acids and fungus, and shall be capable of sustaining a 100% overload without damage or permanent set.

c) Be tested for load Vs deflection and for natural frequency with known aging properties and a history of application in floating floor installations.

d) Be tested in service impact insulation class (IIC) and sound transmission class (STC) by an testing laboratory.

Specifications of the kinetics model Roll-out floating floor System:

1. The noise isolation system shall consist of (2”) 51 mm thick high density pre-compressed molded fiberglass pads separated by low density acoustical fiberglass, the density and spacing of the isolation pads shall be designed by the isolation material manufacturer or his representative on the basis of final evaluation of dead and live loads and in no case shall the uniform load range be less than 1000 kg/sq.m to maintain a constant natural frequency of 15 Hz or lower and uniform deflections of the floating floor. The isolation material shall be shipped to job site in 1.22 m x 15.24 m rolls, 12 mm plywood as the concrete pouring form.

2. The isolation pads shall be spaced at 24 inch centers 61 cm each way and bonded to low density sound absorption material 1 ½ in (38 mm) thick with Noise reduction coefficient of 0.87.

3. Junction plates for maintaining planar alignment of the wood panels shall be 4”x4” 16ga steel attached at four points to the panel system.

4. Perimeter isolation board shall be ¾ “ thick closed cell expanded polyethylene installed around all perimeters, curbs, duct and pipe penetrations.

5. 6-mil (150 micron) Polyethylene sheeting for temporarily waterproofing the isolation system.

6. The floating floor shall consist of minimum 4 inch thick heavy aggregate (2400kg/m3) reinforced concrete.

7. Perimeter sealant (2-component Polysulfide or approved equal)

- Penetrations such Piping, conduit and ductwork penetrations of the floating floors shall be isolated with ¾ inch, closed cell expanded polyethylene.

- Floor drains (if needed) shall consist of two part units designed to be cast into the isolated slab and the structural slab with no rigid connection

between the two members. The drains shall allow for drainage of the air space. The upper member shall contain a grate appropriate to the system.

57 TESTING

The Engineer shall witness all testing and commissioning and shall have access at all reasonable times to such parts of the Contractor's and Suppliers' works as may be necessary for the purpose of inspecting, examining and testing the materials, workmanship and performance.

58 NOTICE PRIOR TO TESTING

The Contractor shall give the Engineer seven days' written notice of his intention to carry out a test and shall have carried out all necessary adjustment prior to commencing the test.

59 TESTING IN SECTIONS

The Contractor shall allow for testing and commissioning the installation in sections as may be required in order to conform with the program. All pipework and ductwork in these sections shall be sealed and tested as specified below, so that the insulation can be applied and the section completed to assist the program.

60 TESTING OF PIPEWORK, WELDS, ETC.

The whole installation shall be hydraulically tested to twice the working pressure of the systems.

Gas pipework shall be tested as above, but utilizing an inert gas.

The pressure shall be maintained for a period of two hours in each case, and due allowance shall be made for attendance by the Engineer during the progress of such tests. The Contractor shall also be responsible for arranging for the water authority to witness this test should they require to do so. Any equipment fitted not suitable for this pressure shall be adequately protected or isolated from the system during the test.

All leaks are to be immediately repaired and the installations retested until the above requirements are obtained.

The Contractor shall allow for such emptying and refilling and maintenance until all leaks have been satisfactorily stopped.

Upon completion of the final hydraulic test on the system, the Contractor shall apply heat and open all valves and charge the calorifiers.

All valves and stopcocks throughout the system shall be adjusted and regulated until all circuits are working under normal conditions and to the satisfaction of the Engineer. Joints found to be faulty under heat are to be completely remade.

All tests are to be carried out before application of the paint or insulation and valve adjustments made with the circulating pumps in operation.

The Contractor shall ensure that before informing the Engineer of the proposed tests, all remedial work has been carried out and that there are no leaks. Failure

to comply with this Clause could result in a charge being made by the Engineer to the Contractor for the abortive visit.

Each welder shall be assigned a reference, which shall be stamped on each weld and when the general hydraulic tests of the completed systems are carried out, each weld shall be lightly hammered during the time that pressure is maintained.

If any leaks occur at welds, the portion of the weld near the leak shall be cut out and rewelded. Such leaks shall not be repaired by caulking or attempted fusion of the surrounding metal. Should a considerable portion of the welded joints made by a particular operator be found to be defective due to faulty workmanship, all such welds shall be cut out and rewelded by another - operator, whose work has proved satisfactory.

During the progress of the Works, inspection will be made by the Engineer to ensure that all burrs and swarf have been removed from cuts and that the cuts have been made square.

The Engineer reserves the right to instruct the Contractor to cut open any sections of the pipework to inspect cuts or to have welded joints laboratory tests.

If the test and inspection should prove that the welds are to the required standard or that all burrs and swarf have been removed, the Client will pay costs incurred by the Contractor in removing testing and replacing the Sections of pipework. If, however, the inspection and test show that the welds or cuts are below the class of workmanship for this class of work, or if they are found to be faulty in any respect, the Contractor shall make good any such faults free of cost to the Client and shall pay all fees incurred by the tests.

If, in the opinion of the Engineer, this result suggests that the standard of workmanship on the whole of the rest of the work is below that required, the Engineer shall be entitled to instruct the Contractor to remove the remainder of the sections in whole or in part and have these sections renewed to conform with this Specification. The Contractor in this case shall have no claim for the costs involved in removing and renewing these sections of the works, whether such Works are found to be faulty or not.

The Engineer's decision shall be final.

61 TEST CERTIFICATES

The Contractor shall at the time of the test present copies of a test certificate for signature by the Engineer and one to be retained by the Contractor.

Insurance company certificates of hydraulic test held at the Manufacturer's work shall be submitted for boilers calorifiers, cylinders.

Manufacturers' certificates, of test at the specified duties held at the manufacturers' works shall be submitted for pumps and fans. No item of equipment shall be delivered to Site before the Engineer has given his approval of the test certificate.

Where no test pressures at factory are given, the test shall be carried out on Site in accordance with the appropriate British Standard (current edition) and subject to the Engineer's approval.

62 TESTING, BALANCING AND COMMISSIONING

1) Scope

Inspect, test, commission and monitor all mechanical services systems and equipment included in this contract together with associated control systems and panels.

Provide all personnel and equipment necessary to carry out the required inspections, tests and commissioning operations including the employment of specialists who would provide and operate testing and monitoring facilities.

2) Related Work Under Mechanical Sections

This section shall relate to all sections included in this contract.

3) Guarantees

Attention is directed to provisions of the General Terms and Conditions and Special Conditions regarding guarantees and warranties for work under this contract.

4) Testing Agency

The contractor shall employ without extra cost to the owner the testing and commissioning and mechanical services to a company approved by the Engineer regularly engaged in providing a testing and commissioning service and who has been in continuous business for not less than 5 years employing fully trained staff having not less than 2 years dedicated experience. A senior experienced commissioning technician shall be responsible for supervising and directing the activities of the commissioning team.

A fully commissioning team shall be provided throughout the full period of commissioning. Changes to the staffing of the commissioning team shall only be made at the request or approval of the Authorized Representative.

The company shall have no vested interest in Project, such as sales of equipment, services etc. and shall not be partly or wholly an owned subsidiary of any vested or interested party, contractor or sub-contractor.

5) Standards

All inspection, testing and commissioning procedures shall conform to the current editions and amendments thereto of the following standards and codes not withstanding current statutory and legal requirements and any other standards and codes which shall apply.

C.I.B.S. Commissioning Codes;

Series B - Boiler Plant
Series C - Controls
Series R - Refrigerating Systems
Series W - Water Distribution systems
BSRIA Application guides and Technical Notes

D.W.142 Specification
British standards and Codes of Practice
I.E.E. Regulations
Local Authority Regulations and Bye-Laws
Health and Safety at Work Act
Government Regulations
Insurance Company(s) Requirements

6) Tests

All tests shall be witnessed and test certificates signed by the Authorized Representative upon satisfactory completion of the tests. One copy of the signed certificate shall be immediately handed to the Authorized Representative.

7) Notice

Clear notice required by the Authorized representative of testing and commissioning activities.

Off site tests	:	14 days
On site tests and inspection	:	2 days
Start up of major plant	:	7 days
Performance tests	:	14 days

8) Submittals

Four (4 No.) copies of all testing and commissioning documentation shall be submitted in bound covers indicated as follows:

A. Certificates:

1. Equipment test certificates
2. System(s) test certificates
3. Welding test certificates if applicable

B. Data Sheets and record manuals:

1. Data sheets of test equipment to be used.
2. Full commissioning and testing data presented on approved record forms for all systems and equipment.

C. Drawings:

1. Equipment detail drawings for equipment.
2. Circuit diagrams for each system with design and actual flow rates and other pertinent data shown.

D. Record forms:

1. Specimen copies of all commissioning record forms shall be submitted for approval of their use on this project.

2. Forms shall be A4 size paper for loose leaf binding, with blanks for listing of the required test ratings and for certification of report.

E) Program of work:

Fully detailed program of work for inspecting, testing and commissioning the works, shall be submitted for approval.

9) Instruments

A.i) All necessary instruments for commissioning and testing as defined in the C.I.B.S.E codes and this specification, shall be included.

ii) All instruments shall have been calibrated within a period of six months and carry a certificate of calibration to that effect. The instruments shall be selected to provide an accuracy compatible with the readings to be taken and the tolerances specified.

iii) The accuracy of the instruments shall be demonstrated to the Authorized Representative and the use thereof shall be subject to his approval.

B. Test instruments shall be available for use to obtain the readings and recorded data required, and shall include but not be limited to the following:-

1. Temperature and humilities:

   a) Electronic thermometers
   b) Mercury in glass thermometers
   c) Aspirated/sling hygrometers

2. Pressures:

   a) Manometer gauges
   b) Magnehelic gauges (diaphragm actuated)
   c) Pressure gauges
   d) Test pressuring equipment

3. Liquid Flow

   a) Manometer gauges across venturies, orifice plates, valves or equipment.
   b) Anuber (Pitot) gauges
   c) Flow meters
   d) Portable pumps

4. Rotational Speeds:

   a) Direct read out electronic digital tachometer
   b) Revolution counter and stop watch

5. Sound Levels:

   a) Sound spectrum analyzer

6. Electrical:

a) Ammeters
b) Voltmeters
c) Multi-meters

7. Vibration:

   a) Accelerometer

8. Recording Instruments:

   a) Hydrothermograph
   b) Multi-point temperature/humidity recorder (plotter)
   c) Digital pressure recorder (plotter)
   d) Sound level recorder

10) General Requirements

A) Definitions:

1. Commissioning: The advancement of the installation from the static completion to full working order calibrated to design requirements, involving the setting-to-work and regulation of the installation (s).

2. Testing: The evaluation of the performance of the commissioned works.

   NB: Preliminary checks on the static installation will carried out by the commissioning Engineers to ensure that it is in a satisfactory and safe condition immediately prior to start up.

B) The Contractor shall apply for, obtain and pay for all permits, tests and inspections that may be required by any of the authorities or agencies having jurisdiction in the performance of the work.

C) Under the adjudication of the Authorized Representative, the Contractor shall coordinate, supervise and carry out all inspection, testing and commissioning activities within an agreed program period.

D) The Contractor shall prepare, submit and agree with the Authorized Representative a detailed program of work defining for each stage: activities, sequence of work, time scales, manpower requirements, start and completion dates and working areas of the building to which access will be required.

E) The Contractor shall allow for carrying out testing and commissioning of the works in phases/stages.

F) The Contractor shall allow for carrying out activities in an occupied building with premium working out of normal office hours in the evening and at weekends.

G) All defects of workmanship, materials, performance design of equipment, maladjustment's or other irregularities, which become apparent during tests, shall be rectified and the tests repeated to the Authorized Representative's satisfaction and at no cost to the contract.

H) Where equipment requires inspection or certification by an insurance company during construction adequate notification shall be given of the date when the equipment will be ready for examination. This shall also apply to on site tests to be witnessed by an insurance company.

I) Before any electrical circuit is energized an "Application for Supply" shall be made. This shall be delivered 24 hours before the supply is required and shall be accompanied by a Test Certificate showing the witnessed values of insulation, resistance and earth fault loop impedance obtained.

J) Before any installation is subjected to site testing or commissioning it shall be thoroughly cleaned both internally and externally.

11) Off Site Tests

When called for by the Authorized Representative or where British Standards or Codes of Practice stipulate tests on items of equipment to demonstrate compliance, these tests shall be carried out at the manufacturer's works or elsewhere, as appropriate. In certain cases, where appropriate, type test certificates will be accepted as follows:

a) Pumps: Type Test Certificates for head, discharge, speed and power input (BS 599)

b) Electric Motors: Type Test Certificates in accordance with BS 5000. For motors of 40 Kw output and above, routine (individual) test certificates in accordance with BS 5000.

c) Starters and control gear: Type Test Certificates BS 587. for control panels as a whole routine (individual) high voltage test in accordance with BS 587.

d) Other electrical equipment, such as air heaters (but excluding thermostatic control equipment): Test Certificates in accordance with BS 6220.

12) On Site Tests

Carry out pressure tests on all ductwork and piping systems in accordance with the requirements of this specification, in Section 2.00 and relevant clauses:

Where fire protection systems are installed they shall be installed in stages to suit the program of work, but upon construction of the first 18 meters in height they shall be capped off at this height and hydrostatically tested this section of the riser shall then be made operative to provide protection to the building this procedure shall be

repeated floor by floor thereafter until the system has been completed after which the entire installation shall be re-tested.

13) Commissioning

Checks and Procedures

A) Prior to any work being commenced, a through inspection of all systems, plant and equipment shall be carried out to check for installation errors, damage, deterioration cleanliness and readiness for testing and commissioning all defects shall be recorded in detail which shall be rectified before work can proceed.

B) When the above procedure has been satisfactorily completed the sequence for each main system shall comprise:

i) Mechanical and electrical engineering safety checks.

ii) Start up and run machines. Pumps shall not be run until system flushing is complete unless used for dynamic flushing.

iii) Regulation calibration or adjustment.

C) The preferred sequence for commissioning the system is:

i) Flushing and pre commissioning cleaning only of water systems.

ii) Commissioning of air distribution systems.

iii) Filling, venting, water treatment, start up and regulation of water systems.

iv) Functional checks on thermal controls associated with water distribution.

v) Commissioning of boiler and calorifier plants and associated controls.

vi) Commissioning of air conditioning and refrigeration plants including associated controls.

vii) Commissioning of controls for air conditioning and ventilation plant.

viii) Commissioning of fire and other safety control circuits including instrumentation, sensing and remote indication.

D) The precise sequence may have to be adjusted for readiness of plant and suitability of weather conditions, subject to the prior approval of the Authorized Representative.

E) i) All water systems, air distribution systems, plant and equipment and control systems shall be fully commissioned in accordance with the C.I.B.S. Commissioning Codes and this Specification.

Where connections to existing services are required, the existing services shall be thoroughly checked and tested also cleaned and repaired where necessary before connecting into new systems.

ii) The tolerance for adjustment of air flow rates shall be generally as stated in C.I.B.S. Commissioning Codes but subject to agreement with the Authorized Representative. Water flow rates shall be adjusted such that volumes to each branch shall be ± 10% of design values and pump volumes shall be + 10%, - 10% of the design value.

iii) The detailed procedure for preliminary checks, setting to work and regulation of the works shall be carried out strictly in accordance with the relevant C.I.B.S. code(s).No deviations to these procedures shall be made without the prior written approval of the Authorized Representative.

iv) Commissioning shall not be considered as complete until the Authorized Representative's approval has been obtained.

v) During the commissioning period of controls arrange for a controls systems engineer to be available on site until the controls systems have been fully commissioned and the witnessing of proving tests have been carried out.

vi) Particular attention shall be paid to the following features:

- Satisfactory operation of any automatic of manually operated sequences to be used in the event of fire.
- Safety in the event of failure and of sudden resumption of electricity supplies.
- Satisfactory operation of safety interlocks designed for the protection of personnel, such as those associated with the high voltage side of equipment and with remote electrically operated plant.

The following item shall checked and/or tested:

- Set desired value of all control devices.
- Satisfactory operation of equipment protection devices.
- The functional correctness of all on/off sequencing interlocks, operations and alternate working selections, automatic or manual change-over of duplicate plant, and modulation ability of all control systems.

vii) The satisfactory operation of all make-up, drain and overflow arrangements shall be checked. Where water treatment is included initial commissioning shall be carried out and then rates of flow, dosing quantities etc. shall be calibrated and set for routine operation. Where controlled blow down is included the controlling device shall be calibrated and set for routine operation.

viii) Damper setting positions shall be scribed on completion of air system balancing.

14) <u>Testing and Commissioning of Controls, MCC's</u>

a. General

All control panels and motor control centers when specified shall be pre-tested at works prior to delivery.

Where it is necessary for the Architect or his Representatives to visit places away from the Works for supervision or inspection in compliance with the Contract, the Contractor shall pay the traveling, subsistence and accommodation expenses of the Architect and his Representation.

Commissioning shall be carried out in accordance with theses requirements together with the C.I.B.Cý.S. Commissioning Code 'C' and relevant I.E.E. Codes and British Standards for testing equipment.

The commissioning shall be completed within the time scales laid down by the Authorized Representative of the Engineer.

The Tender shall include for the provision of all equipment and apparatus necessary for carrying out commissioning and testing on site and to certify that the specified commissioning procedures have been carried out.

b. Static Checks

Checks shall be carried out on all control components to ensure proper location and installation. All anomalies shall be corrected.

Checks shall be carried out to ensure that all control circuit wiring is complete and is safely and correctly installed.

Checks shall be carried out on circuit continuity and earth leakage.

Visual inspection shall be made of all associated motors and equipment to ensure conditions are safe prior to start-up and running.

Checks shall be carried out on rating of all fuses and overloads, and on settings of all safety devices to design requirements.

c. Commissioning

All control systems shall be progressed from the completion of the static installation to full working order, calibrated to design requirements.

d. Testing

All control systems shall be fully tested to check:

1) Functional correctness

2) Modulating ability
3) Sequence operation and interlocks
4) Operation of safety circuits and devices
5) Control ability within design limits

All information relating to controls including set points, control bands limits, pressures, temperatures, etc. The information shall be logged for tabulation and inclusion in the maintenance and operation instructions.

Fault and limit conditions shall be simulated to ensure correct response occurs.

Performance tests shall be carried out to demonstrate that the control systems operate safely and correctly in accordance with the specification and are acceptable to the Authorized Representative of the Engineer.

e. Inspections

Pre-Installation Inspection:

The area and conditions under which the control systems are to be installed shall be examined and any unsatisfactory conditions detrimental to the proper and timely completion of the work shall be corrected. The work shall not proceed until unsatisfactory conditions have been corrected in a manner suitable to the Authorized Representative of the Engineer.

f. Post-Installation Check:

The services of an experienced and competent Engineer/Technician of the manufacturer or supplier of the equipment shall be provided to visit site to inspect, check, adjust if necessary and approve the installations.

The equipment supplier's Engineer/Technician shall be present when equipment is placed in operation.

15) <u>Commissioning records</u>

1. During the commissioning of the installation(s) the results of all checks and measurements taken for all systems and equipment shall be tabulated and recorded on approved record sheets. System and equipment design data shall also be tabulated on the same from for comparison.

2. Written records are to be maintained, throughout the commissioning and testing, of all measurements made, and all settings and adjustment imposed on the plant. This shall include precise details of all thermal controls, including sensitivities, proportional bands, integral times and delay times. They shall be submitted to the Authorized Representative for approval, as they are prepared at each stage of the works.

3. All data shall be collated and produced as a single commissioning and testing record manual, enclosed in a loose

leaf ringed plastic covered binder. On completion, a draft copy of the manual shall be submitted for approval prior to the production of the three final copies.

4. The information recorded shall include but not necessarily be limited to the following, and shall also include all plant data including name of manufacturer, type of equipment, model number, system reference, etc.:

•Pumping equipment

Water flow rate	L/S
Static pressure	m/water
Suction pressure	m/water
Discharge pressure	m/water
Pump speed	R.P.M.
Pump power (absorbed)/phase	Amp/Amp/Amp
Motor speed	R.P.M
Motor power (name plate) FLA	Amp.

• Heat exchangers:

Primary water flow	L/S
Primary water on/off temps.	°C
Primary water pressure drop	m/water
Secondary water flow	L/S
Secondary water on/off temps.	°C.
Secondary water pressure drop	m/water
Duty	Watt

• Water systems (piping & Control Valves)

Flow through main and sub-circuits	L/S
Flow through control valves	L/S
Pressure drop through control valves	m/water
Pressure drop across strainers	m/water
Supply temperature	°C.
Return temperature (after coil)	°C
Return temperature (after mixing valve)	°C.

• Motor data:

Name plate power (FLA)	Amp
Voltage	V
Motor absorbed power/phase	Amp/Amp/Amp
Cycles	
Starting current	Amp

• Controls:

Set values of all control devices
Control bands on all control devices
Set values of all protection devices.

• Steam boilers and calorifiers

Duty	KW
Steam Output	kgs/hr
Water "on" temp.(calorifiers)	°C
Water "off" temp (calorifiers)	°C
Water pressure drop (calorifiers)	m/water

Control thermostat setting	°C
Safety thermostat setting	°C

- Expansion Tanks

H.P Operation	bar
H.P Switch setting	bar
L.P Operation	bar
L.P Switch Setting	bar
P.R.V. Switch Setting	bar
P.R.V. Setting	bar
Level in break tank	mm.
Float switch operation	mm.
Float switch setting	mm.

- Terminal Units

Damper motor operation
Interlock with hood and extract fan

- Cold rooms and freezer rooms

Refrigerant Type	
Room temperature	°C
Ambient temperature on condenser	°C
Compressor suction pressure	bar
Compressor condensing pressure	bar
Sight glass indicator (full/partial)	
Compressor motor absorbed power	Amp/Amp/Amp
Compressor motor power rating FLA	Amps
Compressor motor applied voltage	V
Compressor motor rated voltage	V

16) Performance Tests

A. Carry out and supervise the operation of the commissioned installations for such a period as necessary to satisfactorily evaluate and demonstrate to the authorized representative, the performance of the installations by use of measuring and recording instruments that the installations function correctly and maintain the required conditions within the specified limits.

B. Provide artificial loads as required for the purpose of simulating internal and external loads.

C. During the trial period, plant and building conditions shall be checked and monitored, all necessary adjustments made and recorded on final report sheets.

D. During the trial period, provide training to the clients nominated staff in the operation of the plant.

E. No test or trial shall be carried out while conditions are abnormal.

G. Provide the Authorized Representative with 14 days clear notice of roposed commencement date of performance tests.

17) Equipment Cards

Install at each piece of equipment a "Check out" card showing all significant operating temperatures, pressures, amperes, voltages, power consumption flow rates, resistance, etc. Check out cards shall be standard 125 mm. x 200 mm. stiff index card enclosed in a clear film card folder, securely attached to equipment, or wall in immediate areas.

18) MANUFACTURER'S NAMEPLATES

Nameplates: Each item of mechanical equipment and plant shall have the manufacturer's name or trademark on a corrosion-resistant metal nameplate, securely affixed in a conspicuous place. The manufacturer's name or trademark may be cast integrally, stamped or otherwise permanently marked upon the item of the equipment. The nameplate shall show the equipment reference number, date of manufacture and the capacity. Such other information as the manufacturer may consider necessary to complete identification shall be shown on the nameplates.

19) Documentation

The whole of the information requested in this specification including:-

- Plant data
- Test certificates
- Commissioning records
- Performance test reports
- Circuit diagrams

shall be collated, indexed and assembled into manuals having vinyl covered loose leaf ring binder covers with the project title and then words "Commissioning Data" permanently printed on the front cover. The commissioning companies name, address and telephone number shall be printed on the inside of the front cover.

Four sets of the above manuals shall be handed to the Authorized Representative within ten weeks of the completion of commissioning and performance tests. The installation shall not be accepted until the final approved manuals have been handed over.

APPENDIX I
MINIMUM THICKNESS OF INSULATION

Size of Pipe in mm			Minimum Thickness (mm) of Insulation		
Steel	Copper	All Cold Water System, Cold Feeds & Open Vents	L.T.H.W. D.H.W.S. Systems	M.T.H.W. Systems Condense	H.T.H.W Systems & Steam
15	15		25	32	50

20	22		25	50	50
25	28		25	50	50
32	35		25	50	50
40	42		25	50	50
50	54		25	50	50
65	67		25	50	50
80	76		25	50	50
100	108		50	50	75
125	133		50	63	75
150	159		50	63	100
200	-		50	63	100
250	-		63	63	100
300	-		63	75	100
350	-				
External and in plantrooms (all sizes)		50	50	50	100

Declared Thermal Conductivity (w/m per °C)	Up to 0.06	Up to 0.040	Up to 0.040	Up to 0.040	Up to 0.055

APPENDIX II

EQUIPMENT VIBRATION ISOLATOR SCHEDULE

Equipment	Location	Type Description	Isolator minimum static deflection (mm)
Pumps Above to 3 kw	All	Type 2 / A	25
Air handling units	Floor mounted	Type 2	25
Air handling units	Suspended	Types 3 &5	25
Fan Coil units	Suspended	Type 4	25
Axial or centrifugal fans	Suspended	Types 3 &5	25
Axial or centrifugal fans	Floor mounted	Type 2	25
Fire – tube & steam boilers	All	Type 2	25
Engine-driven generators	All	Type 2	25
Air compressors	All	Type 2	25
Condensing units	All	Type 2	25

END OF SECTION 15020

SECTION 15082

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes hot water piping insulation and cold water piping insulation inside the building , on the building roof and car parks .
   1. Insulation Materials:
      Flexible elastomeric.
   2. Adhesives.
   3. Mastics.
   4. Factory-applied jackets.
   5. Tapes

B. Insulation systems shall include:
   1. Piping insulation, jacketing and accessories.
   2. Equipment insulation and jacketing and coating and accessories.
   3. Ductwork insulation and jacketing lining and accessories.
   4. Firestopping.
   5. Accessories.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Samples: For each type of duct, equipment and pipe insulation and jacket indicated. Identify each Sample, describing product and intended use.

C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of pipe, duct and equipment insulation and finish to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by the Engineer. Use materials indicated for the completed Work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

PIPE INSULATION

A. Provide insulation as indicated and specified.

B. The following piping systems shall be insulated:
Domestic hot water systems inside and outside the buildings.
Domestic cold water systems on the roof exposed to the sun and in the
The car parks .

C. Pipe Insulation :-

1. This type of insulation shall apply to domestic hot water pipes supply and return , domestic cold water pipes on the roof exposed to the sun and on the car parks and shall be completely and fully wrapped with plastic tape.
2. Pipe insulation shall be flexible elastomeric, closed cell expanded rubber 12mm thick, density 65-80kg/m^3. Insulation shall be chemical and oil resistant, self extinguishing, and shall withstand a temperature ranging from 40°C to 120°C, with UV protective coating as recommended by insulation manufacture

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Manholes.
   5. Handholes.
   6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent

pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
   1. vapor-barrier mastic and flashing sealant.

3.6 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by the Engineer. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.7 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

END OF SECTION 15082

SECTION 15126

METERS AND GAGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes meters and gages used in mechanical systems:
   1. Thermometers.
   2. Pressure Gages.
   3. Test plugs.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for meters, thermometers and gages indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of meters, thermometer and gage, signed by product manufacturer.

1.5 QUALITY ASSURANCE

A. Materials and work shall conform to the latest edition of specifications and industry standards and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

B. Certification: Provide meters whose accuracies, under specified operating conditions, are certified by manufacturer.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Case: Brass 9 inches (229 mm) long.

B. Tube: Red or blue reading, mercury filled, with magnifying lens.

C. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

D. Window: Glass.

E. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

F. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

G. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Liquid-filled type, cast aluminum 4-1/2-inch (114-mm) diameter.

B. Element: Bourdon tube or other type of pressure element.

C. Movement: Mechanical, connecting element and pointer.

D. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Brass.

H. Connector: Rigid, bottom type.

I. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch (114-mm) diameter with holes for panel mounting.

B. Element: Bourdon tube or other type of pressure element.

C. Movement: Mechanical, connecting element and pointer.

D. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Brass.

H. Connector: Bottom union type.

I. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.4 BIMETALLIC-ACTUATED DIAL THERMOMETERS

A. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

B. Case: Liquid-filled type, stainless steel with 3-inch (76-mm) diameter.

C. Element: Bimetal coil.

D. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Stainless steel.

H. Connector: Adjustable angle type.

I. Stem: Metal, for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.5 THERMOMETER WELLS

A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
   1. Material: Brass, for use in copper piping.
   2. Material: Stainless steel, for use in steel piping.
   3. Extension-Neck Length: Nominal thickness of 50 mm, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
   4. Insertion Length: To extend to one-third of diameter of pipe.
   5. Cap: Threaded, with chain permanently fastened to socket.
   6. Heat-Transfer Fluid: Oil or graphite.

2.6 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
   1. Material: Brass, for use in copper piping.
   2. Material: Stainless steel, for use in steel piping.
   3. Extension-Neck Length: Nominal thickness of 50 mm, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
   4. Insertion Length: To extend to one-third of diameter of pipe.
   5. Cap: Threaded, with chain permanently fastened to socket.
   6. Heat-Transfer Fluid: Oil or graphite.

2.7 PRESSURE GAGES

A. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type.
   1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch (114-mm) diameter.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   6. Pointer: Red metal.
   7. Window: Glass.
   8. Ring: Brass.
   9. Accuracy: Grade A scale.
   10. Vacuum-PressureRange: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
   11. Range for Fluids under Pressure: Two times operating pressure.

B. Remote-Mounting, Dial-Type Pressure Gages: indicating-dial type.
   1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch (114-mm) diameter with holes for panel mounting.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   6. Pointer: Red metal.
   7. Window: Glass.
   8. Ring: Brass.
   9. Accuracy: Grade A scale.
   10. Vacuum-PressureRange: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
   11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:
   1. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
   2. Snubbers: NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS

A. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

B. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

C. Core Inserts: One or two self-sealing rubber valves.

D. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and

thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install thermometers in the outlet of each domestic, hot-water storage tank.

B. Install case-type, actuated dial thermometers at suction and discharge of each pump.

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees where thermometers are indicated.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install remote-mounting pressure gages on panel.

F. Install needle-valve and snubber fitting in piping for each pressure gage.

G. Install test plugs in tees in piping.

H. Install permanent indicators on walls or brackets in accessible and readable positions.

I. Install connection fittings for attachment to portable indicators in accessible locations.

J. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

K. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 15126

SECTION 15130

PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The extent of pump work is indicated on drawings and in schedules, and by requirements of this section. Belt-driven pumps are not to be used, unless a direct drive unit cannot meet the design parameters.

B. The types of pumps specified in this section include the following:
1- Submersible Waste Water and Rain Water pumps.

1.02 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of all pumps types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years

B. Compliance: Pump and motor shall comply with the requirements of EN and IEC standards.

C. All pumping units shall be designed and built for twenty-four hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation, without excessive vibration or strain and requiring only that degree of maintenance generally accepted as normal for the specific type of pump required. Pumps not meeting the specified requirements shall be rejected.

D. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

E. The Agent or Authorized Dealer should be registered in Jordan for not less than 5 years, and should have experience in selling, installing and maintaining pumps systems in Jordan.

F. Guarantee: **The pump set shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's pump specifications installation and operating instructions, and current accurate pump characteristic performance curves with selection points clearly indicated. (Total Dynamic Head, Pump Efficiency, Brake Horse Power expressed in KW, Net Positive Suction Head, Power Input).

B. Shop Drawings:

1. Submit drawings and information necessary for final design of foundations, structural supports, connected piping and valves electrical connections, starting and protective equipment and auxiliary equipment.

2. Submit for all pumping units, a dimensional drawing of the complete pump, drive and all associated equipment furnished. Such drawing or drawings shall show plan, elevation and any other view or section requested.
3. For all pumping units a scaled cross-sectional drawing of the assembled pump showing full details and materials of construction shall be submitted for approval.

C. Maintenance Data: Submit maintenance data and spare parts lists for each type of pump. Include this data in installation and operating instructions manual.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver and store pump products in factory-wrapped packages, which properly protect pumps against weather, dirt and damage.

B. Handle pumps carefully to avoid damage to motors, components, enclosures and finish.

PART 2 - PRODUCTS

2.01 GENERAL

A. General: Provide tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. **The Contractor shall calculate the head for all pumps based on his actual layouts as approved shop drawings and shall submit calculations for Engineer's approval**. Provide pumps of same type by same manufacturer, where possible. Select pumps to operate at an efficiency of 70% or higher, where possible.

B. Pumps shall be manufactured and installed in such a way that pump suction is always flooded.

C. Pump system shall have duplex or triplex pumps to provide 100% capacity with one pump out of service.

D. Pumps shall be designed to permit disassembly without piping disconnections.

2.02 Submersible Waste Water and Rain Water pumps (SUBP-1) & (SUBP-2):

A. pump set shall be of two pumps, one duty and one standby to the sizes shown on the project drawings and schedules.

B. pumps shall be suitable for dry pit installation and with cooling jacket for discharge size din 80mm and above. Each pump shall be complete with non-return valve and isolating ball valve on the pump discharge. These valves shall be fitted above the normal highest liquid level and in a location accessible from the surface as shown in drawings.

C. Pumps shall be supplied complete with control panel for automatic operation and auto changeover of duty/standby pumps. Control panel shall have visual/audible alarm.

D. Pump components shall be manufactured of the following materials: -
Motor : Explosion proof 3 - phase or single phase, insulation class F, protection type IP68.
Pump housing : Grade 304 stainless steel or cast iron to BS1452 grade 20.
Impeller : Grade 304 stainless steel or cast iron to EnGJL 250 .
Pump sleeve : Grade 316 stainless steel.
Shaft : Grade 304 stainless steel.
Bearing : Heavy-duty pre-lubricated ball bearings.
O-rings : Neoprene rubber.

E. Local isolators shall be located adjacent to the sump for isolation of units during maintenance.

F. Discharge pipe within sump between pump and valves shall be heavy-duty reinforced rubber hose.
G. Pumps shall be furnished with stainless steel pulling chains.
H. Pump shall be provided with a built in grinder or Vortex Impeller with new no clogging .
I. Pumps shall be provided with a duck foot elbow and cast iron or ductile guide rail.
J. The control panel shall be constructed of 1.5 mm thickness sheet steel and IP65 protection.
K. The control panel shall include all features and components shown in the drawings.
L. The sequence of operation described in the drawings shall be tested at the completion of the works.

PART 3 - EXECUTION

3.01 INSTALLATION OF PUMPS

A. General:

1. Install pumps where indicated, in accordance with manufacturer's published installation instructions, with recommended clearance provided for service and maintenance.

2. Ensure that pump units are wired properly, with rotation in correct direction, and that pump and motor grounding have been provided. Refer to Division 16 for power wiring.

1. The pumps to be checked for correct rotation and meet the specified details regarding performance duty.

2. Install gate or butterfly valve and strainer on suction side of pump and a pressure gauge piped to read both suction and discharge. On the discharge side install silent check valve and double regulating valve. Flexible connections shall be installed on both sides of pump. Inlet piping shall be arranged to prevent the possibility of cavitations.

3. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitations, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

4. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For base mounted pumps, install supports under elbows on pump suction and discharge line sizes 100 mm and over.

5. Install pumps on vibration isolators. Refer to Section 15070.

6. Install flexible connectors at or near pumps on suction and discharge pipes.

B. Base-Mounted Pumps: Unless otherwise indicated, install on minimum of 100 mm high concrete base equal or greater than 3 times total weight of pump and motor, with anchor bolts poured in place. Set and level pump, grout under pump base with non-shrink grout.

1. Pump and motor must be checked for alignment after the pump base has been installed and grouted in place. There shall be no strain transmitted to the pump. The concrete support shall be as recommended by the manufacturer and detailed on drawings. Provide cast supports in the lower half for securely bolting the pump body to the base plate. Suitable lifting lugs shall be provided to lift each part individually. Suitable instruments drain and vent connections, and other accessories shall be provided.

2. Anchor Bolts - Pump Bolts: Anchor bolts and nuts shall be steel and shall be furnished by pump manufacturer. Acceptable special washer and nuts to be furnished on the lower ends of the bolts unless pockets provided for access to the nuts. Expansion bolts shall not be used for anchoring pumping equipment.

3. Pump Connections: Pumps shall be provided with flanged inlets and outlets that are compatible with the pipeline to which it is connected.

4. Suction and Discharge Elbows: Provide each pump with a suction elbow enclosed by the base or foundation. A reducing elbow shall be provided where suction pipe is larger than the suction flange. The suction and discharge connections shall be of the same pressure ratings as the adjoining pipes and fittings and shall be of such sizes that the velocity of each opening shall not exceed 3.6 m/sec.

C. In-line Pumps: Support from piping system, and locate for access to oil cups, service, and maintenance.

END OF SECTION 15130

SECTION 15150

SANITARY WASTE STORM AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for sanitary drainage and vent piping, and storm drainage piping inside the building and to locations indicated:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

1.3 DEFINITIONS

A. Sewerage Piping: Building sewer piping outside building that conveys sanitary sewage from building.

B. Drainage Piping: Building sewer piping outside building that conveys storm drainage from building.

C. Service Entrance Piping: Drainage piping at entry into building between outside building sewer piping and inside drainage piping.

D. Drainage and Vent Piping: Piping inside building that conveys waste water and vapors from fixtures and equipment throughout the building.

E. Force-Main Piping: Drainage piping, under pressure.

F. The following are industry abbreviations for plastic and other piping materials:
   1. EPDM: Ethylene-propylene-diene polymer, rubber.
   2. NBR: Acrylonitrile-butadiene rubber.
   3. PVC: Polyvinyl chloride.
   4. PP: Polypropylene.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
   1. Soil, Waste, and Vent Systems: 30 kPa (10-foot head of water).
   2. Storm Drainage Systems: 30 kPa (10-foot head of water).
   3. Sewage, Force-Main Piping Systems: 690 kPa (100 psig).

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events, ASCE 7.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
   2. Solvent Drainage System: Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. The plumbing pipework shall comply fully with the latest relevant British Standards or DIN Standards as specified .

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. The above ground drainage installations shall mean all pipe work inside buildings and located as follows.
   a. Above floor slab.
   b. Under tiles.
   c. Embedded in walls.
   d. At high level or low level exposed or concealed.
   e. All vertical pipes (risers).
   f- All drainage pipe work installed belowground slab

C. The below ground drainage installation shall mean all drainage pipe work installed between manholes and buried underground either outside building or in basement level.

D. POLYPROPYLENE PIPES AND FITTINGS (PP) (for above ground drainage installations):
   1. Silent PP mineral reinforced polypropylene pipes and fittings with sound insulation layer, high molecular density not less than 1.6 g/cm^3, to DIN 4102-B2 and DIN 4109, 95C water temperature,self extinguishing, fire and chemical resistant.
   2. Joints of pipes and fittings shall be made with push fit joints with EPDM or SBR rubber ring.
   3. Installation, supporting and jointing of PP pipes and fittings shall be as per manufacturer recommendations and instructions.
   4. Direct embedded pipes in concrete walls shall be as per manufacturer recommendations and instructions.
   5. Pipe ends must be square, free from burrs, smooth and clean before joining is carried out.

6. The pipes and fittings should be produced according to EN 1451, DIN 4109, DIN 14366 and DIN 4102.
7. Sound level as per DIN 4109 shall not be more than 20 DB at flow rate of 4 l/s, behind a wall of 220 kg/m2. Certificates shall be provided.
8. To maintain the fire resistance of Fire walls and floors when they are penetrated by the soil system, either a fire collar needs to be installed.
9. The pipe system needs to be resistant against continuous temperatures of 90°C and peak temperatures of 100°C.
10. Expansion compensator socket needs to be installed, as recommended by the manufacturer.
11. Use full encircling brackets with rubber inserts.
12. Each pipe section between floors must be secured by a fixed bracket.
13. Every horizontally installed pipe should always be fixed with one fixed bracket.
14. Installation to be according to the manufacturer installation instructions
15. Date of manufacturing for pipe and fittings shall not be more than two years of date of the submittal.
16. Pipe thickness shall be not less than:
    Diam 50: thickness 4.0mm
    Diam. 75: thickness 4.5mm
    Diam. 110: thickness 5.3mm
    Diam.160: thickness 5.3mm
    Diam.200: thickness 6.2mm

E. UPVC PIPES AND FITTINGS
1. UPVC pipes and fittings manufactured to (BS EN 1401.1:1998) standards suitable for Below ground application and to (BS EN 1329.1:1998) standards suitable for above ground application.
2. All joints for all sizes for pipes and fittings shall be push fit type.
3. All pipe and fittings shall be from one manufacturer .

F. UPVC PRESSURE PIPES AND FITTINGS
1. UPVC pressure pipes and fittings manufactured to DIN standards suitable for pressure (16 bar) PN16.
2. All UPVC pipework shall be ultra violet resisting.
3. UPVC socket or threaded fittings of the same rating as pipes.

2.4 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Shielded Nonpressure Pipe Couplings: elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: sleeve-type reducing- or transition-type mechanical coupling molded from TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

E. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections. Select and assemble components for expansion indicated. Include ductile-iron glands, rubber gaskets, and steel bolts.

F. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends. Include ductile-iron glands, rubber gaskets, and steel bolts.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

3.2 PIPING INSTALLATION

A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

B. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

D. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 75) and smaller;1 percent downward in direction of flow for piping NPS 4 (DN 110) and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by the Engineer

3.3 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 15 Section "Valves."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
1. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
2. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Backwater valve are specified in Division 15 Section "Plumbing Specialties."

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports."

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but notsmaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but notsmaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but notsmaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main or sanitary manhole.
2. Sewage Pumps: To sewage pump discharge.

3.6 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15150

SECTION 15155

DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following drainage piping specialties:
1. Floor Drains (FD)
2. Parking Floor Drains (PD)
3. Area Drain (AD)
4. Trench Grate & Frame (TD)
5. Cleanouts (FCO)
6. Roof Vent Cowls (RVC)
7. Balcony drain (BD)
8. Roof Water Drain(RWD)
9. Cleanout – Type (H.F.C.O)
10. Wall Cleanout – Type (WCO)
11. Manhole
12. Gully Trap
13. Camlock Fittings set

B. Related Sections include the following:
1. Division 15 Section "Plumbing Fixtures" for hair interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Grease interceptors.
2. Grease removal devices.
3. Oil interceptors.

B. Shop Drawings: Show fabrication and installation details.
1. Wiring Diagrams: Power, signal, and control wiring.
2. Retain paragraph and subparagraphs below if required by seismic criteria applicable to Project. Coordinate with Division 15 Section "Mechanical Vibration and Seismic Controls."
3. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency..

PART 2 - PRODUCTS

2.1 PLUMBING ITEMS

A. Floor Drain (FD)

1. Floor drain type 75 mm: PPR of same pipe material , with minimum 5 cm trap seal, one outlet and multiple inlets complete with Stainless Steel cover and plate size 15cmx15cm which shall be also equipped with stainless steel screw.

B. Parking Floor Drains(PD)

Supply and install where shown on drawings extra-heavy duty floor drains where shown on the Drawings in Parking areas.

Each drain shall have square heavy-duty metallic compound material resistant grating square 30cmx30cm with lockable strainer (12.5 tons point load rating), but without a trap.

C. Area Drain (AD)

Each area drain shall be bottom outlet no trap type. Each drain shall have square heavy-duty metallic compound material, corrosion resistant grating square 30cmx30cm with lockable strainer (12.5 tons point load rating) with strainer at outlet, but without a trap.

D. Gutter Trench Grate (TD):

Supply and install wherever shown on drawings gutter and grates and frames as hereinafter specified.

Gutter (trench) and Grate (Slotted grille) shall be made of heavy rectangular, sectional bar pattern, of cast iron suitable for heavy traffic with width , depth and length as shown on the drawings , the body enclosure shall be made of heavy duty plastic .

E. Cleanouts (FCO)

Supply and install cleanouts wherever shown on the Drawings and of sizes as detailed on the Drawings.

Each cleanout shall be of the same material and dimensions as the pipe to be cleaned, and shall be placed at ceiling level, in walls, or slabs, as need be, for ease of operation.

Ceiling pipe cleanouts on PVC or PP-R pipes shall be shall have access plug and screw caps of the same material.

Floor clean outs shall be covered with stainless steel access cover (150x150mm), screwed odor-tight with a backwater-proof seal up to 0.5 bar

F. Roof Vent Cowl (RVC)

Roof vent cowl shall be provided for all vent pipes as shown on the drawings. Roof vent cowl shall be made of the same material of the pipe.

G . Balcony Drain(BD)

Shall be made of ABS. with inserted cover from synthetic material and outlet size 75mm.

H. Roof water drain (RWD)
Abs or plastic ,**side wall roof drain** with sealing flange for connection to polymer pipe outlet size 110mm, all screws shall be made of stainless steel .

I. Cleanout – Type (H.F.C.O)

Heavy Duty adjustable floor cleanout, with Dura-coated cast iron body with gas and water tight ABS tapered thread plug, and round scoriated secured top and Dura-coated cast iron cover adjustable to finished floor as to Zurn Z1400 or approved equal.

The FCO is for use in conjunction with the standard pipe fittings forming cleanout branch at each change in direction, greater than 45° or near the foot of every vertical stack and on long horizontal pipe runs at 12m intervals.

The clean out shall be installed such that it opens opposite to the direction of the flow of the drainage system or at right angles thereto.

J. Wall Cleanout – Type (WCO)

Recesed NPT threaded plug for use in conjunction with the standard pipe fitting forming cleanout branch at each change in direction, greater than 45° or near the

foot of every vertical stack and on long horizontal pipe runs at 15m intervals. The clean out shall be covered with Stainless steel polished top and frame access cover.

The clean out shall be installed such that it opens opposite to the direction of the flow of the drainage system or at right angles thereto.

K. MANHOLES

Cement and Concrete

a) Cement

All cement used in all classes of concrete for drainage and sewerage works, whether above or below ground level, shall be sulphate resistant cement, complying with BS 4027

b) Granolithic Concrete

Granolithic Concrete shall be mixed using one part by weight of Portland cement to two parts of clean granite chippings graded as Table 1 of BS 882, to one part of sharp siliceous sand graded as Table 2 and clear water sufficient to form a stiff but workable mix and provide a dense concrete.

c) Cement Mortar

Cement mortar shall consist of sulphate-resisting cement and sand gauged by volume in suitable boxes in the proportions as proposed by BS standards

Unless otherwise specified cement mortar shall be SRC Class No.1.

The ingredients of the mortar shall be mixed in an approved mechanical mixer or shall be mixed together dry on a clean wooden stage until the mix is homogeneous in colour. Water shall then be added through a rose in sufficient quantity to give no more than stiff workability. The Whole shall then be turned until perfectly mixed.

Mortar shall be used within 30 minutes of mixing and shall not be remixed or worked up again after it has stiffened. Any mortar that has commenced to set shall be removed from the works.

Concrete Classification

CONCRETE GRADE	CHARACTERISTIC STRENGTH N/mm^2	APPLICATION
SRC 30	30	Precast Concrete
SRC 25	25	Normal reinforced concrete, blinding thrust blocks
SRC 25	25	Mass concrete hard standings
SRC 20	20	Mass concrete, pipeline protection and surrounds protection to tanking and hollowing block infill.
MIX PROPORTION FOR CEMENT MORTAR		
PROPORTION BY VOLUME FOR CEMENT		
Cement	Sulphate Resisting	Sand Lime

CONCRETE GRADE	CHARACTERISTIC STRENGTH N/mm^2	APPLICATION
No. 1.	1	2 -
No. 2.	1	3 -
No. 3.	1	5 1

RENDERING TO MANHOLE BEDDING

- Rendering to manhole benching shall comprise a 12mm thick layer of approved epoxy mortar.

Manholes Generally

General

Manholes shall be provided at all changes in direction, gradient or diameter.

The manholes shall be of the sizes and grades indicated on the Contract drawings and fully comply with MOPW regulations and Construction Specification

Block work Manholes

Block work manholes shall be constructed on the drain lines in the positions and to the dimensions indicated on Drawings or as directed on site by the Engineer.

The type of construction for each chamber shall be as indicated on the Contract Drawings.

Concrete blocks used for chamber construction shall be manufactured with sulphate resisting cement and shall comply with the requirements of MOPW Construction Specification

Hollow concrete blocks shall be filled solid with concrete Grade SRC 20.

Each manhole shall be built on a minimum of 75mm thick blinding of grade SRC 25 concrete which shall be laid on a dry clean firm foundation free from unsold material. If the bed of the excavation is wet, the top surface of the blinding shall be coated with an approved waterproofing material.

Foundation base slabs shall be cast in-situ. Mass concrete foundation slabs shall be of concrete Grade 20. Reinforced concrete foundation slabs shall be of Grade SRC 30.

Internal and external faces of the block work walls shall be finished with 12mm thick SRC mortar rendering Class 1.

All internal faces of manhole chambers except benching and vitrified clay channel fittings shall be painted with one primer coat and two final coats of black bitumen coating water proofing solution to BS 3416, type 1 or equal and approved.

All exterior faces of manhole chambers shall be protected with 1000-gauge polythene membrane with hardboard protection against damage during backfilling.

Where indicated on the Drainage, manhole cover frames shall be supported on solid precast concrete bricks, manufactured from Grade SRC 30 concrete.

Reinforced cover slabs shall be provided where manhole access openings are less than the internal dimensions of the manhole chamber.

The cover slabs shall be mounted by ductile manhole covers and frames of the quality specified. The covers in roads and paved areas

shall be accurately set on precast concrete brickwork to the level and slopes of the roads or pavements.

Manhole inverts shall be constructed of half section vitrified clay channels. Half section vitrified clay channel branch bends shall be used for branch connections. Benching in manholes shall be carefully formed according to the number, diameter and positions of the incoming and outgoing pipes. The benching in the manholes shall have vertical sides extending from the verified clay channels at least to the level of the crown of the highest pipe. The benching shall be sloped towards the channels at gradient of 1 in 10 or as otherwise detailed on the drawings. The benching shall be rendered with a 12mm thickness of epoxy mortar rendering. The ends of all pipes entering and leaving the manhole are to carefully cut to shape to suit the internal dimensions of the manholes, and shall project through on the inside, the benching being

Continued round the pipe to form a fillet.

Precast Concrete Manholes

The base shall be cast in-situ and shall be Grade SRC 20 concrete to the dimensions shown on the drawings.

The whole base including the outside surround to the pipes shall be cast monolithic. Immediately before concreting, lengths of pipes to be built in shall be surrounded with a layer of cement mortar No. 1.

The formwork for all precast concrete rings shall be purpose made in mild steel and shall incorporate surface vibrators of adequate performance to ensure proper compaction of the concrete. The forms must have provisions for allowing the casting in of the step irons. All precast components for manholes shall be made in accordance with BS 5911 or equivalent approved standard. Precast concrete components shall immediately after the removal of forms, be sprayed with an approved curing membrane. Regular spraying with water will not be an acceptable method of curing.

Where the Contractor does not own forms with surface vibrators for the production of precast concrete manhole components he may, with the written approval of the Engineer employ an approved method of hand compaction. If the Engineer gives such written approval, this does not imply acceptance of the quality of the finished work.

The positions of lifting holes or eyes in precast components are to be approved by the Engineer. Lifting holes are to be grouted up after construction of the manhole.

Step Irons

Step irons are to be positioned in the chamber shaft rings in such manner that the step irons are vertically linear. The joints at each step iron shall be made water-tight and strong, free from any crack and if found otherwise the Engineer may reject the precast ring or may instruct the Contractor to take any necessary measures to make the ring watertight.

The first step iron shall be fixed at a maximum of 600mm below the cover level and the last

step iron shall be fixed at a maximum of 300mm from the top level of the lowest adjacent benching.

Step irons shall be staggered at 300mm centres vertically and horizontally.

All joints between rings or slabs shall be made watertight to the satisfaction of the Engineer with a bituminous mastic strip sealant as approved. The external face of the joint is to be sealed with epoxy mortar.

Chamber Rings

Chamber rings shall be manufactured from concrete Grade SRC 30.

Both internal and external surfaces of the chamber rings shall be coated with a solution of bitumen refined from asphaltic crude oil, the solution having total solids content of approximately 45% and a viscosity corresponding to a No. 4 for cup time of approximately 30 seconds.

Manhole Covers and Frames

In general, manhole covers and frames shall be one of three types, as follows, unless otherwise specified.

- Heavy Duty, to BS 497 Grade A
- Medium Duty, to BS 497 Grade B1
- Light Duty, to BS 497 Grade C

Heavy Duty

All manholes installed in roadways or trafficked areas shall be heavy duty Ductile cover to BS 497 Grade A, Reference MA 60.

The cover and frame shall be made from ductile iron and the cover shall be of the loosely bolted double triangular type with three-point suspension to provide stability under load.

Medium Duty

All manholes installed external to buildings, but not in roadways or trafficked areas, shall be medium duty to BS 497 Grade B1.

The cover and frame shall be of ductile iron and the cover shall be either rectangular or circular as specified in the Manhole Schedule. Such manholes shall incorporate a single seal between cover and frame. Following flushing out and testing of the drainage system, the sealing groove shall be filled with grease to provide an airtight seal.

Light Duty

All manholes installed within buildings and not subject to motor vehicles or industrial trolleys etc. shall be light duty to BS 497 Grade C of the lockable type.

The cover and frame shall be made from grey iron and shall incorporate a double seal between cover and frame. Following flushing out and testing of the drainage system, the sealing grooves shall be filled with grease to provide an airtight seal.

In those areas where it is required to accept a tiled floor finish, the manhole covers shall be of the recessed type. In kitchens, or other areas subject to washing down, manhole covers and frames shall have stainless steel edging and trim. Double-cover units shall be provided where specified in the Manhole schedule.

The Contractor shall provide two sets of lifting keys for each type of manhole.

Manhole covers and frames shall be as approved.

Recessed Covers

Where manholes installed within tiling or decorative floor finish surroundings, a recessed type manhole covers shall be installed.

The cover and frame shall be made from galvanized steel cover and frame and shall incorporate a double seal between cover and frame. Manhole covers shall be fastened to frames by heavy-duty counter sunk screws. Floor finishing shall be rendered continuously within the manhole covers to match the surroundings.

Following flushing out and testing of the drainage system, the sealing grooves shall be filled with neoprene to provide an airtight seal.

In kitchens, or other areas to washing down, manhole covers and frames shall have stainless steel edging and trim. Double-cover units shall be provided where specified in the Manhole schedule.

The Contractor shall provide two sets of lifting keys for each type of manhole.

Manhole covers and frames shall be as approved.

L. Gully Trap (G.T):

Gully Trap size 150 mm: PP of same pipe material, with minimum 7 cm trap seal, one outlet 110 mm and multiple inlets 110 mm complete with heavy duty plastic cover from PP and plate size 20cmx20cm accordance with BS EN 13598 – 1 and BS EN 7158.

M. Camlock Fittings set:

These fittings set as shown on drawings must be size 4” - close tolerance all of them made of 316 grade stainless steel, include:

- Male Adaptor: which is connected with uPVC pipes.
- Female Coupler Cap: it’s a cap for the Male Adaptor.
- Hose Tail Coupler: which is connected with Sewage truck’s hose.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction.
   3. Locate at minimum intervals of 15 m for piping NPS 4 (DN 100) and smaller and 30 m for larger piping.
   4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   2. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

J. Install through-penetration fire-stop assemblies in plastic conductors and stacks at floor penetrations.

K. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions

Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   1. Position roof drains for easy access and maintenance.

L. Install deep-seal traps on floor drains and other waste outlets, if indicated.

M. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

N. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

P. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

Q. Install vent caps on each vent pipe passing through roof.

R. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain (25-mm) clearance between vent pipe and roof substrate.

S. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

T. Install grease separators, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
   1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
   2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
   3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
   4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

U. Install oil separators, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and manufacturer recommendations.

V. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Grease separator
   2. Oil separator

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled grease removal devices and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Apply static test of 3.0m head for at least two hours.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain grease and oil separators.

END OF SECTION 15155

SECTION 15410

COLD WATER SERVICES

INDEX

CLAUSE NO	TITLE
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2	Pipework General
3	Valves
4	Thermal Insulation
5	CPVC Pipework
6	Strainers
7	Flushing
8	Testing and Commissioning
9	Chlorination
10	Concrete Water Reservoir Accessories:
11	Float Valves
12	Pressure Sensors
13	Hose Bib
14	Pressure Reducing Valve
15	Packaged Variable Speed Booster Pump Set
16	Packaged Booster lifting Pump set
17	Reverse Osmosis Unit (RO)
18	Electric Water Heater (EWH).
19	Polyethylene Tank
20	GRP Tank

SECTION 15410

COLD WATER SERVICES

1 GENERAL REQUIREMENTS

The cold water system shall be executed as shown on the drawings, complete with all water distribution piping, water reservoir piping, pumps, etc.

The Contractor shall be responsible for providing the main cold water supply pipe and accessories from the mains including obtaining the necessary permits, performing all legal matters and making the tie-in to the water source in accordance with local codes, regulations and requirements of the water authorities having jurisdiction and including the provision of the water meter or orifice installation as might be required and as instructed by the authorities or the Engineer, all on his own account.

Underground water pipes shall not be run in the same trench as sewer pipes. Adequate precautions shall be taken for protecting underground water pipes from contamination from any source.

Flow control devices shall be provided on cold water service branches to maintain the design velocities. The process of regulating flows irrespective of pressure should also achieve a degree of water conservation.

2 PIPEWORK GENERAL

The pipework shall be as specified in section 15020 / Plumbing and Fire Fighting of these specifications unless otherwise mentioned in this section.

3 VALVES

The valves shall be as specified in section 15020 / Plumbing and Fire Fighting of the specifications unless otherwise mentioned in this section.

4 THERMAL INSULATION

All cold water pipework inside the building shall not be thermally insulated.

5 CPVC PIPEWORK

Refer to section 15020 / Plumbing and Fire Fighting.

6 STRAINERS

Refer to Section (15020).

7 FLUSHING

The whole of the pipework installation shall be flushed out as detailed in section (15020) of these specifications.

8 TESTING AND COMMISSIONING

The testing and commissioning of the cold water services shall be carried out as described in section (15020) of these specifications.

9 CHLORINATION

After testing of the pipework and prior to making the connection to the new town mains supply all pipework shall be satisfactorily chlorinated in accordance with BS Code of Practice No. 310.

10 Concrete Water Reservoir Accessories:

The Contractor shall be responsible for furnishing and installing all piping connections, into the water reservoirs such as water inlets, vents, overflows, drains, puddle flanges, pump suctions, stainless steel 316 leaders on both sides and stainless steel 316 louver door openings, …etc., as shown on the drawings and of sizes as shown thereon.

The Contractor shall install the piping connections into the walls of the reservoirs at the time the concrete is poured. He shall be responsible for correctly locating the connections at their exact required locations and for taking the necessary precautions not to have them dislocated when concrete is poured and for preventing concrete from entering into them.

Piping connections into the reservoirs shall be of stainless steel 316 pipe, with threaded ends for connecting to threaded fittings and valves and with flanges screwed on to them where it is necessary to connect them to flanged fittings or valves. They shall be of suitable lengths to project 5 cm. within the reservoirs and 15 cm. beyond the outside wall of the reservoirs.

All piping connections embedded in the concrete walls of the reservoirs shall be provided with no-leak flanges which shall consist of a square stainless steel 316 plate, 6 mm. thick, of dimensions 15 cm. larger than the pipe, with a hole in the center equal to the outside diameter of the pipe. The flange shall be welded all around the pipe at a location as to fit in the center of the wall to prevent water leakage around the pipes all as detailed on the drawings.

Open ended piping connections into the reservoirs such as vents and overflows shall be properly screened to prevent the entrance of insects, vermine and foreign matter into the reservoirs. The screens shall be of galvanized steel wire mesh not less than 10 mesh per square centimeter and shall be fitted to the open end of the pipe in an approved manner.

The entrance of pump suction pipe in the water reservoir shall be provided with stainless steel vortex plate.

11 FLOAT VALVES

Float valves shall be of all brass construction including levers and arms, with plastic float and shall be suitable for a cold water working pressure of 10 bar. Float valves size 50 mm. and smaller shall have screwed inlets and size 65 mm. and larger shall have flanged or grooved inlets.

Float valves shall be of the full bore, equilibrium ball type, designed to close tight against maximum pressure when half submerged. They shall have renewable synthetic rubber valve disk and balancing piston bucket.

Float valves shall conform to BS 1212 and BS 1968.

12 PRESSURE SENSORS

Pressure sensors shall be installed in strategic points in the cold water systems as recommended by the pump set manufacturer.

The pressure sensors shall be connected to the main domestic cold and softened water boosting sets. This is maintain the required pressure throughout the circuit which serves all buildings.

13 HOSE BIB

Hose Bib shall be finished chrome plated red brass, compression type with four arm cross removable metal handle and standard hose threads.

14 PRESSURE REDUCING VALVE

Valve shall be such that complete replacement of inspection of any part can be made without removal of the valve body from the pipe. Valve shall be provided with a by- pass arrangement complete with all valves and pressure gauges, as detailed on the drawings (for more details refer to section 15020).

15 PACKAGED VARIABLE SPEED BOOSTER PUMP SET (FOR DOMESTIC COLD WATER) (DCWBP-1)

The booster pump set shall be completely automatic and skid mounted unit assembled. The pumps installed on the pump set shall be approved by WRAS.

The pump manufacturer shall have been in the business of manufacturing complete pumping systems for minimum of 10 years.

The pump set shall maintain constant delivery pressure by means of a frequency converter for each pump to control speed of pumps.

Pump set shall include the following features:-

1. Two vertical multi-stage pumps with high efficiency motors and drives.
2. Variable frequency driver with digital read out for each pump to be installed inside the control panel.
3. Copper or stainless steel suction and delivery manifolds with flanged connections.
4. Copper ball isolating valves and flexible connections on suction and delivery for each pump.
5. Check valves on delivery for each pump.
6. Strainer on suction on the main connection pipe for the pump header.
7. Pressure gauge at discharge manifold and transducer pressure
8. Control panel.
9. Pressure vessel on discharge main fold as recommended by the pump manufacturer.
10. Weather resistance painted Heavy-duty steel metal louvered box with door.

11. Skid plate shall be heavy duty epoxy painted equipped with vibration absorber.

The pumps impellers, guide vanes, shafts and outer sleeves shall be stainless steel.

The pump motor shall be squirrel cage induction type and rated for continuous operation at ambient temperature not less than 50°C.

The motors shall be totally enclosed fan cooled type with insulation class (F) and IP54 protection and rated for 400 volt, 3-phase and 50 cycle.

The control panel shall be constructed of 1.5 mm thickness sheet steel and IP65 protection.
The control panel shall include all features and components shown in the drawings.

The sequence of operation described in the drawings shall be tested at the completion of the works.

QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of all pumps types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

C. The Agent or Authorized Dealer should be registered in Jordan for not less than 5years, and should have experience in selling, installing and maintaining punps systems in Jordan.

D. Guarantee: **The pump set shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

E.

16 PACKAGED BOOSTER LIFTING PUMP SET (FOR DOMESTIC COLD WATER) (LP-1)

The booster pump set shall be completely automatic and skid mounted unit assembled. The pumps installed on the pump set shall be approved by WRAS.

The pump manufacturer shall have been in the business of manufacturing pumping systems for minimum of 10 years.

Pump set shall include the following features:-

1. Two Vertical multi-stage pumps with high efficiency motors and drives.

2. Copper or stainless steel suction and delivery manifolds with flanged connections.
3. Copper ball isolating valves and flexible connections on suction and delivery for each pump.
4. Check valves on delivery for each pump.
5. Strainer on suction on the main connection pipe for the pump header.
6. Pressure gauge at discharge manifold.
7. Control panel.
8. Skid plate shall be heavy-duty epoxy painted equipped with vibration absorber.
9. Weather resistance painted Heavy-duty steel metal louvered box with door.

The pumps impellers, guide vanes, shafts and outer sleeves shall be stainless steel.

The pump motor shall be squirrel cage induction type and rated for continuous operation at ambient temperature not less than 50°C.

The motors shall be totally enclosed fan cooled type with insulation class (F) and IP54 protection and rated for 400 volt, 3-phase and 50 cycle.

The control panel shall be 1.5 mm thickness sheet steel and IP65 protection.

The control panel shall include all features and components shown in the drawings.

The sequence of operation described in the drawings shall be tested at the completion of the works.

QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of all pumps types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

B. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

C. The Agent or Authorized Dealer should be registered in Jordan for not less than 5years, and should have experience in selling, installing and maintaining pumps systems in Jordan.

D. Guarantee: **The pump set shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

17 Reverse Osmosis Unit (RO)

RO unit shall be package type with tank and presser pump, its hall have a seven stages filtration process including a UV minimum production rate shall be 4 L/Hour, the RO unit shall be USA manufactured origin.

18 Electric Water Heater (EWH)

Small sizes electrical heaters shall be furnished with residential (EWH). The residential electric water heater shall be of storage type with heating capacity and storage capacity on schedule of equipment. Heater shall be rated at 240 volt single phase, 50 HZ and UL listed and approved. Heaters shall have a maximum working pressure of 10 bars. And an energy factor of 0.95 or greater.

The tank shall be of double skin injected with insulation foam of R21 insulation value. The jacket shall full size compartments for the performance of service and maintenance through front panel openings and enclose the tank with foam insulation.

The internal surfaces of the cylinder shall be of glass lined.

The outer surface shall be treated cleaned and bake enamel paint finished for extra protection against corrosion

The tank shall be provided with 20mm tapping and temperature pressure relief valve and with a sacrificial anode rod for maximum cathodic protection. The tanks shall also be provided with two isolating valves, vacuum breaker, non return valves, drain cock and thermometer.

The controls shall include a thermostat with each element and high temperature cut out switch.

19 Horizontal & Vertical Polyethylene TANK

Food grade Polyethylene tanks shall be constructed from 6 layers:
as per followings:
1. First Layer (External): prevents dust absorption and blocks UV ray that could result to material degradation, comes in various colors as desired by the client.
2. Second Layer (Black): makes the tank opaque. Thus, preventing growth of microorganisms.
3. Third , Fourth and Fifth Layers: isolating outside temperature or providing insulation to keep water temperature less affected by heat especially during summer.
4. Sixth Layer (Inner White): a layer of smooth snow-white to prevent any accumulation of impurities or bacterial growth in the inner surface of the tank. It is also resistant to corrosion & Erosion. to keeps the water healthy and pure.
The tank lid shall be strong enough to allow a man to safety work on it. The tank shall be complete with a hinged & lockable lid and air vents. The tanks shall be mounted on 200mm clear height, galvanized steel strip plinths.
The tanks shall be hydraulically tested on site for 48 hours. If there are any leaks the tank shall be repaired and re-tested. On completion of testing and prior to putting the tank in use, it shall be carefully cleaned thoroughly and disinfected.
All tanks operating at atmospheric pressure shall be tested under "tank full" conditions for tightness and structural soundness.

All potable water tanks shall be subject to a standing leak test for 24 hours, during which time all joints shall be carefully examined. Any defects shall be rectified immediately and the test repeated.

20 GRP TANK

Supply, install test &commission GRP water tanks for soft, collection treated, clarifier and clarified water reserve, outside surface shall be protected with UV. Stabilizers, supported from inside as in BS.5950, all internal metallic supporting materials to be A4/316 Stainless steel, including screws, bolts, and provided with 60 CMS top opening. with cover, suitable float valve, interior stainless-steel ladder, and exterior aluminum, concrete base 20cm, tank shall be provided with followings openings, over flow, supply line, and drain outlet, water level indicator tube, high- and low-level switches.

END OF SECTION 15410

SECTION 15430

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division-1 Specification sections apply to work of this section. All fixtures shall need prior approval from the Engineer.

1.2 SUMMARY

A. Provide materials, labor, trim and services for the complete installation of plumbing fixtures and related components as indicated on the drawings and specified herein.

1.3 DEFINITIONS

A. Accessible: Plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped, disabled, and elderly people.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, drains and tailpieces, traps and waste pipes. Pipe fittings, tube fittings, and general-duty valves are included where indicated.

1.4 REFERENCES

A. The plumbing fixtures shall comply fully with the latest relevant British and International Standards in all respects.

1.5 WORK CLEANLINESS

A. General: The Contractor shall proceed with all work in a clean and workmanlike manner. Contractor shall keep stored materials, storage areas, and installed systems free of dirt and debris.

B. Provide protective covering for installed fixtures and fittings.

C. Do not allow use of fixtures for temporary facilities, except when approved in writing by Engineer.

1.6 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of plumbing fixtures, whose products have been in satisfactory use in similar service for not less than 5 years.

B. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

C. The Agent or Authorized Dealer should be registered in Jordan for not less than 5years, and should have experience in selling, installing and maintaining solar systems in Jordan.

D. Guarantee: **plumbing fixtures shall be the latest and newest model and latest technology for the manufacturer products** and shall include a (5) five years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits three times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the five years after acceptance . **The Agent or Authorized Dealer shall provide a letter directly to the owner for his commitment on this clause.**

1.7 GENERAL REQUIREMENTS

A. Plumbing fixtures, trim, and accessories shall be from one approved brand, unless otherwise specified.

B. Vitreous ware for the fixtures shall be first quality, non absorbent china. Enamel ware shall be constructed of smooth sound iron castings. Fittings for fixtures shall be first quality in heavy red brass castings properly finished and high quality chrome plated. All wall hung fixtures to be caulked between walls and fixtures. All fixtures should be of vandal proof type.

C. Final type, selection and color of vitreous china fixtures will be decided according to the Architect or Interior Decorator requirements and approval.

D. All specified accessories used in disabled toilets, should be certified for the use by disabled people.

E. All Plumbing fixtures should be delivered to the site complete with all related approved accessories and ancillaries as specified here in this section.

1.8 PROTECTIVE SHELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping.

B. Protective Shielding PipingEnclosures:
   2. Manufactured plastic enclosure for covering plumbing hot- and cold-water supplies and trap and drain piping.

1.**9** DELIVERY, STORAGE, AND HANDLING

A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.

B. Store plumbing fixtures on elevated platforms in dry location.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURE STANDARDS (Refer to details)

2.2 LAVATORIES

A. White vitreous china countertop or semi-pedestal type lavatory with one tap hole for mixer as shown on drawings. Lavatories to be completed with the following trim and accessories:
- Chrome plated P-trap with wall tube and wall flange, adjustable type.
- Wall brackets and Brass chrome plated drain shall be provided
- Two 15mm stop angle valves with 300mm tubes with wall flanges. Similar to (Grohe 22951 00M) or approved equal on quality and appearance.
- The fixture unit and 15mm single hole chrome plated mixer shall be as Described below:

A.1 Lavatory Type (L-1): With Counter Type, size (550x450mm) shall be similar to (Keramag- Impuls 251555) or approved equal on quality and appearance.
And shall be completed with single lever basin mixer, furnished with 35mm ceramic cartridge, adjustable flow limiter, Adjustable minimum flow rate 2.5 lit/min, mousseur, automatic pop-up waste set 32mm, flexible connection hoses. Similar to (Grohe-Eurodisc23449002) or approved equal on quality and appearance.

A.2 Lavatory Type (L-2): Lavatory size (650x550mm) accessible handicapped type similar to (Keramag-Vetalis 221556) or approved equal on quality and appearance.
And shall be completed with 35mm ceramic cartridge, adjustable flow limiter, Adjustable minimum flow rate 2.5 lit/min, mousseur, automatic pop-up waste set 32mm, flexible connection hoses. Similar to (Grohe-Eurodisc23449002 or approved equal on quality and appearance.

2.3WATER CLOSETS

A. Water Closet: Wall hung type as per Architectural requirements and as indicated on drawings, white vitreous China. Water closet to be complete with the following trim and accessories:
   1. White solid plastic seat and cover complete with ABS chrome plated hinge, rubber washers, and chrome plated screws and nuts.
   2. Supporting system for WC.
   - Concealed flush tank with fittings and accessories screwed to wall complete with actuator plate, as shown on drawings and as described hereunder:

A.1 Water Closet type (WC-1),Wall Hung,Size (540x355mm) shall be similar to (Keramag-Impuls 201550) or approved equal on quality and appearance, from the proposed manufacturer list only.

Water closet to be complete with the following trim and accessories:
White solid plastic seat and cover complete with ABS chrome plated hinge, rubber washers, and chrome plated screws and nuts.

Shall be completed with flushing system consist of powder coated steel frame, self-supporting for dry-cladding, completely pre-assembled with fixed connections quick adjustment, lockable fixing material
TÜV approved, 2 WC fixing bolts, fixing device for ceramic
WC ceramics with small bearing area (< 205 mm), outlet bend Ø 90 mm depth, adjustable reducer Ø 90/110 mm, inlet and outlet connecting set similar to (Grohe Rapid SL 38528001).

CISTERN
Adjustment ex. factory 6 L and 3 L, pneumatic discharge valve offering 3 modes of operation: dual flush or start/stop or single flush. water supply from left/right or back. low noise (group I acc. To German Noise Specification). insulated against condensation. ½" water supply connection including integrated, angle valve and push fit flexible hose union, no tools required for the installation of the inspection shaft incl. protection during construction phase.
with Chrome plated Cover plate (similar to Grohe GD2) or approved equal on quality and appearance.

A.2 Water Closet type (WC-2), Wall hang accessible handicapped type as per Architectural requirements and as indicated on drawings, white vitreous china. Size (700x355mm) shall be similar to (Keramag-Vitalis 201500) or approved equal on quality and appearance.
Water closet to be complete with the following trim and accessories:
White solid plastic seat and cover complete with ABS chrome plated hinge, rubber washers, and chrome plated screws and nuts.
Shall be completed with flushing system consist of powder coated steel frame, self-supporting for dry-cladding, completely pre-assembled with fixed connections quick adjustment, lockable fixing material
TÜV approved, 2 WC fixing bolts, fixing device for ceramic

WC ceramics with small bearing area (< 205 mm), outlet bend Ø 90 mm depth, adjustable reducer Ø 90/110 mm, inlet and outlet connecting set similar to (Grohe Rapid SL 38528001) or approved equal on quality and appearance.

CISTERN

Adjustment ex. factory 6 l and 3 l, pneumatic discharge valve offering 3 modes of operation: dual flush or start/stop or single flush. water supply from left/right or back. low noise (group I acc. To German Noise Specification). insulated against condensation. ½" water supply connection including integrated, angle valve and push fit flexible hose union, no tools required for the installation of the inspection shaft incl. protection during construction phase.
with Chrome plated Cover plate (similar to Grohe GD2) or approved equal on quality and appearance.

2.4 KITCHEN SINKS (KS-1)

Stainless Steel, type 304, 1.6mm thickness insert type for fixing into counter top, single bowl and drainer, size (1200x435mm).

A. Sink to be complete with the following trim and accessories.
- 50mm sink waste with stainless steel grating.
- P-trap with wall tube and escutcheon.
- Wall flange for 50mm tube trap.
- 15mm chrome plated single lever sink mixer, with swivel Tubular U-spout, sink mounted complete with stop valves and chrome plated flexible connection hoses with ceramic cartridge. Similar to (Grohe 32488 000) or approved equal on quality and appearance.
- 15mm stop angle valves with flexible tubing and wall flange.

2.5 HAND SPRAY WASH ASSEMBLY (HS)

A. Bibcock with perineal hose: to be of very heavy duty, vandal proof type trigger sprays hand shower head, with wall holder, wall mounted angle valve, and heavy duty chrome plated metal 15mm flexible tube of 1200 mm long. 15mm chrome plated, wall mounted angle valve type with standard threaded outlet. Complete with pressure reducing fitting.

2.7 MISCELLANEOUS ITEMS

A. Flexible tube used for connecting the mixers and taps to angle valves on water inlet, should be of the first quality, heavy duty type, and should be from the same manufacturer of the fixture and to be approved by the Engineer prior to installation.

2.8 FITTINGS

A. Fittings for Equipment Specified in Other Sections: Fittings include the following:
   1. Supply Inlets: Brass pipe or copper tube, size required for final connection.
   2. Supply Stops: Chrome-plated brass, angle or straight; compression, wheel-handle type; same size as supply inlet and with outlet matching supply riser.
   3. Supply Risers: DN10 (3/8-inch NPS) flexible copper tube with knob end. Use chrome-plated tube for exposed applications.
   4. Traps: Tubular brass with 1.1 mm (0.045-inch) wall thickness, with no-leak slip-joint inlet, cleanout, wall flange, escutcheons, and size to match equipment. Use chrome-plated tube for exposed applications.
   5. Continuous Waste: Tubular plastic with no-leak slip-joint inlet and size to match equipment.
   6. Indirect Waste: Tubular plastic and size to match equipment.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Examine the substrates, adjoining construction, and conditions under which the work would be installed. Contractor shall correct unsatisfactory conditions detrimental to the timely and proper completion of the work. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.

B. Install fixtures level and plumb according to manufacturer's written instructions, roughing-in drawings, and referenced standards.

C. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction when no support is indicated.

D. Install individual stop valve in each water supply to fixture. Use gate or globe valve where specific stop valve is not specified.

E. Install water supply stop valves in accessible locations.

F. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.

G. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

H. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1 part, mildew-resistant, silicone sealant.

3.3 CONNECTIONS

A. Concealed brackets, hangers and plates shall have a shop coat of paint.
- All exposed piping and trim shall be chrome plated and fully protected during installation. Strap or padded wrenches shall be used on chrome pipe fittings and valves.
- All exposed metal parts in the sanitary blocks shall be chrome plated.
- All exposed valves in the sanitary blocks shall be chrome plated of the recessed type.

B. Plumbing fixtures shall be complete with all required trimmings, including faucets, waste plugs, traps, supplies, stop valves, escutcheons and casings and all necessary hangers, plates, brackets, anchors and supports.

3. Fixtures shall be set in a neat, finished and uniform manner making the connection to all fixtures at right angles with the walls, unless otherwise directed by the Engineer.
   - Roughing for this work must be accurately laid out so as to conform with the finished wall material.
   - Fixtures are not to be set until so directed by the Engineer.

C. The location and disposition of all items shall be as indicated on the relevant or drawings.

D. Install piping connection between plumbing fixtures and piping systems and plumbing equipment.

E. Arrange for electric power connections to fixtures and devices that require power.

3.4 FIELD QUALITY CONTROL

A. After the piping has been pressure tested, and the fixtures have been set and trim piped, but prior to practical completion, each fixture supply and drain shall be flowed to observe proper dynamic action to the set.

B. Contractor shall notify the Engineer in writing at such time as the potable water systems, drainage, waste and vent piping, and plumbing fixtures are complete and ready to be flow tested on an acceptable basis.

C. Check that fixtures are complete with trim, faucets, fittings and other components.

3.5 EQUIPMENT HANDLING

A. The Contractor shall furnish all supervision, labor, tools and equipment to relieve, unload, uncrate, inspect, move, disassemble, store, assemble, set in place, align and secure all equipment including all auxiliary items and components.

B. Adequate weather protection of all equipment and equipment parts is to be furnished and maintained at all times by the Contractor

C. Stored equipment shall be protected from the elements and physical damage. Installed equipment shall be protected from damage until final acceptance.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot-water dispensers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flush tanks having controls, to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Clean fixtures, faucets, and other fittings, including flush tanks, with manufacturers' recommended cleaning methods and materials. Include the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from flush tanks and drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities, except when approved in writing by Engineer.

END OF SECTION 15430

HVAC SPECIFICATIONS INDEX

SECTION NO.	TITLE / CONTENTS
15010	BASIC MECHANICAL REQUIREMENTS
15060	HANGERS, SUPPORTS AND FIRE STOPPING
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15075	MECHANICAL IDENTIFICATION
15120	PIPING SPECIALTIES
15739	SPLIT SYSTEM AIR CONDONING UNITS
15837	FANS

SECTION 15010

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

I. This Section covers the basic general requirements applicable to all Division 15 works that shall be provided for by the Contractor.

II. The following specifications may be used as a guide for pricing but the Contractor will be fully responsible for the mechanical services as indicated diagrammatically on the drawings and to supply complete Mechanical Services Installations to the approval of the Engineer and complying with the aesthetic requirements of the Architect/Interior Designer.

1.2 CALCULATIONS

A. The Contractor shall acquaint himself with the constructional details of the buildings and exterior works both before and during the course of erection and shall take his own particulars with regard to the installation of mechanical equipment. The Contractor shall check the sizes of all mechanical equipment taking into account any additions or deletions required to ensure the installations fit into the room or other spaces allocated and in relation to other plant and equipment being provided.

B. The Contractor shall undertake and prepare all necessary calculations and drawings relating to the mechanical systems and equipment and for all associated foundation, structural and builder's and services work, except where specifically defined otherwise in the Specification and/or on the Drawing.

III. The Contractor shall provide and submit to the Engineer all calculations, drawings and supporting data for the mechanical equipment.

IV. The Contractor shall provide calculations, details, drawings and technical data to enable the Engineer to ascertain the correctness of the specialist designs of the associated foundations, supports, bases and fixings.

1.3 SUBMITTALS

A. The Contractor shall provide submittals (3 copies minimum) as directed in the individual sections including also compliance sheet, origin catalogues, and samples, and the contractor shall mark up all submitted models and specified information on the catalogue.

B. The Contractor shall provide method statements for installation procedures of ductwork, pipe work, plant, equipment and automatic controls and all specialised systems.

1.4 WORKING DRAWINGS (SHOP DRAWINGS)

A. The Contractor shall provide for approval working drawings of the whole mechanical works. The drawings shall include, but not necessarily be limited to the followings:-

1. Co-ordinated general arrangements of all services to a scale of not less than 1:50

2. Co-ordinated detailed layouts of plant rooms and similar spaces to a scale of not less than 1:20.

3. Schedules of all equipment to be installed, together with starting and full load current and running power consumption along with any integral power factor correction capacitors.

4. Indicate with accurate dimensions sizes and positions of all plant, equipment, pipes, thermal and acoustic insulation, conduits, cable tray, cables together with all inspection points and cable joints.

5. Fully indicate all ductwork, pipe work, sizes and positions of all plant equipment and valves together with all inspection points and test positions.

6. Fully indicate all builders' work requirements inclusive of all foundations, bases, plinths, sumps and holes together with the overall sizes and masses of the plant concerned.

7. Indicate the number, size and services for every cable, duct, pipe for every service within the building.

8. Indicate all equipment and control wiring diagrams for all systems.

9. Show all pipes, cables and ducts in pits and service ducts on drawings to a scale of 1:50 or larger.

10. Show clearly all plumbing and drainage and setting out dimensions for all drainage pipe work and manholes, both within the building and throughout.

11. Services zoning principle in cross-section for each ceiling void area having extensive engineering. The sections are to demonstrate the sizes, dimensions of zones allocated for separate HVAC, public health, electrical, and other engineering services along with services cross-over zones, support/brackets zones thermal insulation, clearance and maintenance allowances to demonstrate the correct coordination.

12. Fully indicate extent and construction/installation details for all acoustic, noise and vibration control systems including inertia bases and plant room.

B. The symbols used for each service for all working drawings shall be shown on separate drawings.

C. In addition to the working drawings, the Contractor shall obtain and provide at the request of the Engineer, two sets of all manufacturers' detailed drawings for all items of plant, equipment, apparatus and materials. These drawings shall be suitably titled and have drawings references number added. Specific requirements are given in the individual specification Sections.

D. All drawings, diagrams and schedules called for in this clause shall be submitted to the Engineer for examination and approval.

E. The Contractor shall make due allowance for an approval/comment period and it must be clearly understood that the correctness of the submitted information will directly affect this comment/approval period.

F. The Contractor shall be responsible for co-ordinating all mechanical, electrical, lift, fire protection, plumbing, drainage and irrigation works, and other engineering systems such that each may be installed in a proper manner, ensuring correct performance and allowing adequate maintenance access. All services shall be installed such that the positioning of ducts, pipes, cables, and all items of equipment avoid conflict. The Contractor's working drawings shall indicate any services co-ordination needs prior to submission to the Engineer for approval; tender drawing shall not be reissued as working drawings.

G. Each drawing shall have blank area of 18 cm X 12 cm located adjacent to the title block and reserved for the comments of the engineer. The title block shall display the following:

1. Number and title of drawing.
2. Date of drawing or revision.
3. Name of project and employer.
4. Name of consultant.
5. Name of contractor and sub-contractor submitting the drawing.
6. Clear identification of contents and location of work.
7. Legend for all symbols.
8. Specification title and number.
9. scale of drawing.

H. the approval of drawing will be general, but approval shall not be constructed as permitting any departure from the contract requirements, nor relieving the contractor of the responsibility for any errors including details, dimentions…etc, and specified performance of equipment.

1.5 CONSTRUCTION DRAWINGS

A. Following approval of the Contractor's drawings by the Engineer, they shall constitute "Construction Drawings" and the E and M equipment shall be manufactured and installed in accordance with those approved drawings. The acceptance by the Engineer of any such drawing shall not relieve the Contractor of his responsibility under the Contract and shall not commit the Engineer or make the Engineer liable for any mistake of the manufacturer's deficiencies in strength or efficiency in operation of any part of any item for its specified purpose.

B. The Engineer reserves the right subsequently to amend or add to the Construction Drawings as may be necessary or expedient.

C. The Contractor shall provide to the Engineer, immediately after approval of each detailed drawing, one copy and two dye-line prints and computer files on CD.

1.6 REGULATIONS

The installation materials and components shall comply with all relevant statutory instructions and regulations current at the date of tender, whether so detailed or not. In particular, the following regulations and standards must be followed: -

A. Standards issued by Jordanian Standards Organisation
B. British and/or American Standard Specifications
C. British and/or American Standard Code of Practice

D. UK IEE Regulations for Electrical Installation
E. US National Electrical Code
F. US National Electrical Safety Code
G. UK Chartered Institution of Building Services Engineers (CIBSE)
H. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
I. Electrical Regulations issued by JEPCO
J. US Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
K. US National Fire Protection Association Standards (NFPA)
L. IEE Regulations for Electrical Equipment of Buildings
M. Local Laws, Rules and Regulations
N. U.K. CIBSE Commissioning codes for Air, Water, Refrigeration and Controls Installations.
O. One copy of all the above codes and standards in hard-copy are to be held on site for the duration of the contract and be available for reference by the Contractors and Clients Site Supervision Teams.

1.7 WORKMANSHIP AND MATERIALS

A. The Contractor shall be responsible for ensuring that the components for each system are mutually compatible and integrated to form fully efficient systems complying with the Drawings and Specification. Corresponding parts throughout the Works shall be made to gauge and be interchangeable wherever possible. The Contractor shall, when required by the Engineer, prove interchangeability by the actual interchange of the various parts.

B. All articles and materials specified to conform to Jordanian, British and other standards shall be clearly and indelibly marked with the appropriate standard number specified except where marking is impracticable when relevant documents shall include this information.

C. All materials and workmanship shall be to the satisfaction of the Engineer. The Contractor shall maintain a competent supervising engineer and supervisors for each specialisation and for each section of the work on Site throughout the whole of the time to the completion of the works. The Engineer shall give prior approval to the appointment of this supervising engineer and shall have the authority to withdraw this approval at any time. No person shall be allowed to execute any type of work that is normally carried out by a skilled tradesman unless he is thoroughly experienced and proficient in the trade concerned. The Engineer shall have the authority to require any tradesman to demonstrate his proficiency to the satisfaction of the Engineer.

D. Where "stainless steel" is specified or used it shall have resistance to atmospheric corrosion and be of a grade to suit its particular use. Particular attention shall be made to the prevention of seizure by fretting where two corrosion resistant metals are in contact, by the selection of materials of suitable relative hardness and surface finish and the applications of lubricants. Where bronze is specified or used it shall be zinc free.

E. Minor defects not exceeding 12.5% of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Engineer shall be notified of larger defects and no repair welding of such defects shall be

carried out without prior approval.

F. If the removal of metal for repair will reduce the stress-resisting cross-section of the casting by more than 25%, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25%, then that casting shall be rejected.

G. Castings repaired by welding for major defects shall be stressed-relieved after such welding.

H. Non-destructive tests will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine that repair welds have been properly made.

I. All major stress-bearing forgings shall be made to a standard specificationthat shall be submitted to the Engineer for approval before work is commenced. They shall be subject to internal examination and non-destructive tests for the detection of flaws and shall be heat-treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for each such forging shall be submitted to the Engineer. The Engineer may arrange for such forgings to be inspected at the place of manufacture with a representative of the Contractor.

J. Particular attention shall be paid to the prevention of corrosion due to the closeproximity of dissimilar metals. Where it is necessary to use dissimilar metals in contact, they shall be selected so that the bimetallic corrosion is as low as possible. The publication by the UK HM Stationary Office entitled "Corrosion and its Prevention at Bimetallic Contacts" shall be used as a guide.

K. The use of iron and steel shall be avoided in instruments and electrical relayswhereverpossible. Steel screws, when used, shall be zinc, cadmium or chromium plated or, when plating is not possible owing to tolerance limitations, shall be of corrosion resisting steel. All woodscrews shall be of dull nickel-plated brass or of other approved finish. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze. Spring shall be of non-rusting material, e.g., phosphor bronze or nickel silver, as far as possible. Pivots and other parts of which non-ferrous material is unsuitable shall be of approved restless steel where possible.

1.8 INSPECTION AND TESTS AT MANUFACTURER'S WORKS

A. The Engineer and his duly authorised representative shall have at all reasonable times access to the Contractor's premises to inspect and examine the materials and workmanship of mechanical equipment being manufactured there, and if part of such equipment is being manufactured on other premises, the Contractors shall obtain for the Engineer and for his duly authorised representative permission to inspect as if that equipment was manufactured on the Contractor's own premises. Such inspection, examination or testing, if made, shall not relieve the Contractor from any obligation under the Contract.

B. All works, materials and the like rejected shall be corrected or replaced

as necessary at the Contractor's own expense to the satisfaction of the Engineer.

C. Where the mechanical equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the manufacturer's works, to the relevant test or tests required.

D. The Contractor shall submit his proposed programme of tests for the Engineer' approval six weeks before the commencement of testing.

E. The aforementioned works tests carried out before delivery to the Site shall not in any way relieve the Contractor of completing satisfactory Site tests after erection as specified.

F. The Contractor shall give the Engineer reasonable notice, at least ten clear days in writing, of the date and the place at which any mechanical Equipment will be ready for testing as provided in the Contract and the Engineer shall thereupon at his discretion notify the Contractor of his intention either to release such part upon receipt of works tests certificates or of his intention to inspect such part. The Contractor shall forward to the Engineer six duly certified copies of all relevant test readings.

E. The Contractor shall provide, free of charge, such labour, materials, electricity, fuel, water, stores, apparatus, instruments and other things as may be reasonably demanded to carry out efficiently such tests of the mechanical equipment in accordance with the Contract, and shall provide facilities to the Engineer or to his authorised representative to accomplish such testing. Where inspection or testing is to be carried out at a Sub-contractor's works, a representative of the Contractor shall be present.

F. Works tests shall also be carried out with due consideration is given to the Site conditions under which the mechanical equipment is required to function. The test certificates shall give all details of such tests.

G. Specific performance works tests are described in the relevant Sections of Division 15, and include all major items of Mechanical, HVAC and Plumbing plant and equipment.

1.9 CERTIFIED DRAWINGS

A. The Contractor shall be responsible for providing all "Certified" drawings from manufacturers of mechanical equipment, prior to their manufacture and installation. A "Certified' manufacturer's drawing shall mean a drawing which is prepared by a manufacturer showing the exact dimensions and details of items of the mechanical equipment, as they will be supplied and installed on the site.

1.10 SAMPLES

A. The Contractor shall provide a sample, properly labelled, of all fittings, valves, insulation, cocks, unions, grilles, dampers, switchgear, cables and other like accessories described in the Specification or as required by the Engineer.

1.11 PROTECTION AND CARE OF PLANT AND EQUIPMENT

A. All mechanical equipment shall be packed in robust containers to prevent damage and mishandling during transport to Site. Before dispatch from works, all mechanical equipment shall be thoroughly cleaned, protected against damage, deterioration, corrosion and ingress of dirt and packedand protected suitable for prolonged storage in a humid and saline atmosphere.

B. During storage and erection at the Site, the mechanical equipment shall be kept clean and free from dirt and debris, and water shall not be allowed to remain in any pockets of the equipment. All items of mechanical equipment shall be stored clear of the ground on suitable timbers to the approval of the Engineer.

C. All mechanical equipment, particularly electrical and other sensitive instrumentation shall at all times be protected so that it is not subject to damage by rainwater, moisture, dust, etc., from any source. Mechanical equipment that may be damaged by heat or sun shall be protected accordingly. All open pipe and duct ends whether installed or in store shall be fitted with plastic caps or suitable protective covering.

1.12 GUARDS

A. A guard shall be provided for all open unprotected intakes to axial fans, centrifugal flow fans, for V-belt drives.

B. Fan guards shall be manufactured by the fan maker, of galvanised steel wire mesh, not greater than 25mm attached to a rigid galvanised steel rod framework.

C. Guards to V-belt drives shall be made of galvanised steel wire of at least 12 gauge, with a mesh notgreater than 12.5mm attached to a rigid galvanised framework of rods of not less than 10mm diameter. The guard shall be readily removable to permit the belts to be changed. Adequate access panels shall be provided in the side of the guard to allow tachometer readings of the two shafts to be taken and belt tension tested. Allowance shall be made for the adjustment of the motor on its slide rails.

1.13 CLEANING

A. The Contractor shall be responsible for cleaning all mechanical equipment at all times to the satisfaction of the Engineer. The cleaning shall be carried out notwithstanding the fact that the installation or any part thereof may be in use or partial use within the premises in occupation by others. A Certificate of Completion will not be issued until the Engineer is satisfied that all dirt, jointing materials and other extraneous and injurious materials have been removed.

1.14 AIR CONDITIONED STORES

A. The Contractor shall provide air-conditioned site stores for all goods that deteriorate when subjected to the site climatic conditions detailed. The contractor will adhere strictly to the Manufacturer's instructions with regard to storage temperatures for all materials being used for the construction of this project.

1.15 PAINTING

A. The preparation, painting and treatment of mechanical equipment surfaces shall be in accordance with relevant items in Division 15 and Division 9.

B. Full details of the manufacturer's standard finishes shall be given to the Engineer for his approval prior to manufacturer. Special care shall be taken to ensure standard finishes are suitable for the particular conditions applicable to the individual items of plant.

C. Any damage to paintwork that occurs shall be made good by the Contractor at his own cost to the satisfaction of the Engineer.

E. All bright metal parts shall be covered before despatch with an approved protective compound and protected adequately during delivery to Site. After erection these parts shall be cleaned with a correct solvent and polished bright where required.

F. Machined mating surfaces such as gear teeth, etc., shall be coated with a thick layer of grease. Other machined surfaces shall be given a coat of rust-preventing paint, which shall be readily removable when required.

G. Where it is the usual practice of the manufacturer of special items such as pumps, compressors, electric motors, gear boxes, switch gear, etc., to apply a high standard of protective enamel paintwork in the shop before despatch, this will be acceptable provided any subsequent damage to the paintwork is made good by the Contractor, at his own cost. The preferred finish is light grey.

H. The inside of outdoor control cubicles, cabinets, etc., where condensation is liable to occur, shall be coated with an approved anti-condensation composition.

I. The Contractor shall obtain the paint manufacturer's guarantee that each coat of paint is compatible with the previous and subsequent coats so that peeling, flaking and other faults do not occur.

J. The Contractor shall include for painting all pipes, ducts, flange edges, etc., prior to their being insulated.

K. Final decoration of exposed pipe work, brackets and ductwork shall be carried out in accordance with Division 9.

1.16 MANUFACTURER'S NAMEPLATES

A. Nameplates: Each item of mechanical equipment and plant shall have the manufacturer's name or trademark on a corrosion-resistant metal nameplate, securely affixed in a conspicuous place. The manufacturer's name or trademark may be cast integrally, stamped or otherwise permanently marked upon the item of the equipment. The nameplate shall show the equipment reference number, date of manufacture and the capacity. Such other information as the manufacturer may consider necessary to complete identification shall be shown on the nameplates.

1.17 LABELS

A. Identification labels of plastic laminate or similar approved materials

engraved black on white unless otherwise agreed, with not less than 5mm "line" style letters shall be fixed on all controls, switches and distribution gear, by means of at least two brass screws. Socket outlets of all voltages shall be similarly identified or engraved.

B. The labels shall bear the identification shown on the Drawings, such as indication, designation, functionand, where necessary, phase, voltage, current, frequency, pressure and temperature. All labels shall be in Arabic and English.

1.18 LUBRICATION

A. The Contractor shall furnish a complete schedule of recommended oils and other lubricants. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Engineer for approval before incorporation in the instruction manuals. In the case of grease lubricated roller type bearings for electric motors, a lithium base grease is preferred.

B. Where lubrication is affected by means of grease, preference shall be given to a pressure system that does not require frequent adjustment or recharging. Frequent, for this purpose, means more than once weekly and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility, grease nipples shall be placed at the end of extension piping and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. Button head type nipples shall be of the same size and type for every part of the plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.

C. Where more than one special grease is required a grease gun for each special type shall be supplied and permanently labelled.

D. Oil sumps shall be fitted with oil level indicators of the sight glass type, or where this is not practical, with dipsticks. The indicators shall show the level of all temperatures likely to be experienced in service. The normal, maximum and minimum levels at 30°C shall be clearly visible in the sight glass type from the normal access floor to the particular item of plant, and they shall be easily dismantled.

E. All sight glasses shall be firmly held and enclosed in metal protection in such a manner that they cannot be accidentally damaged.

F. All lubrication systems shall be designed so as not to present a fire hazard. Particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into current contact with any electrical equipment, heated surfaces or any other potential source of fire.

G. The Contractor shall supply flushing oil for each lubrication system when an item of plant is ready for preliminary running and a sufficient quantity of the approved lubricants for setting to work and for the commercial operation for one year after the relevant Certification of Completion has

been issued.

1.19 SPECIAL TOOLS

A. The Contractor shall supply free of charge two complete sets of any special tools necessary for the operation, maintenance and dismantling of the mechanical equipment. The Contractor shall supply wall-mounted strongboxes; each fitted with a suitable lock and two keys, and located near the item of mechanical equipment for which they will be used. Such tools shall not be used by the Contractor during the erection of the mechanical equipment.

1.20 SUNDRY BUILDERS WORK IN CONNECTION WITH SERVICES

A. The Contractor shall include in his prices for drilling, raw bolting, plugging, screwing and nailing of all brackets and hangers for all pipework, ductwork conduit, cable tray, cable trunking and cable supports. The Contractor shall also include for supplying all brackets, hangers and supports as necessary.

1.21 NOISE

A. Noise Criteria

Refer to Specification Section 15070.

B. The Contractor shall provide a quiet installation. All items of mechanical equipment shown on the Drawings shall be carefully chosen with a view to silent operation. The recommendations in BS 5720 and BS 8233 shall be followed wherever necessary. The Contractor shall prepare detailed noise level calculations to indicate the anticipated noise levels in all occupied areas. Fan chambers, technical rooms and chillers yardshall be constructed to ensure that noise levels in surrounding spaces meet specified levels.

C. All possible steps shall be taken, (e.g. by the use of sound insulation, anti-vibration mountings, floating floors, walls, ceilings and careful design of pumps, motors, fans, ducts, bends, dampers, grilles and other equipment) to reduce the noise produced by the mechanical equipment.

D The Contractor shall determine the noise levels of all primary mechanical equipment before proceeding with manufacture and submit sound power levels of such equipment and resultant room noise levels to the Engineer for approval before manufacture is commenced.

1.22 ANTI-VIBRATION MOUNTINGS AND SOUND ABSORPTION

A. The Contractor shall provide and fix all mechanical equipment to prevent noise and the transmission of vibration through the structure.

B. All fans, motors, compressors, pumps and other items, as appropriate, shall be mounted on resilient mountings in such a manner that the plant foundations are isolated from the floor or structure. Pumps shall be installed on inertia bases. In addition, all rotating plant shall be statically and dynamically balanced.

C. Mechanical vibration shall be eliminated by the use of anti-vibration mountings and flexible connections to ensure an isolation efficiency in

excess of 98% from the building structure except where defined otherwise on the Drawings or in the Specification.

D. Spring type anti-vibration mountings shall be the captive partially encased and restrained type to prevent lateral movement.

1.23 AS BUILT DRAWINGS

A. “As Built” record drawings are to be produced as the installation work is completed. The working drawings shall be checked against the installation, corrected and issued for approval. The Contractor shall provide a delivery schedule of the drawing submissions based on the construction programme. Thirty days prior to the date of the handing over certificate, the Contractor shall provide the final copy of the "as built" record drawings of the whole works for approval.

B. The Drawings shall include the following:-

A. General arrangements of all services to a scale of not less than 1:50.

B. Detailed layouts of plant rooms and similar spaces to a scale of not less than 1:20.

C. Schedules of all plant and cross referenced equipment to the maintenance manual.

D. All equipment and control wiring diagrams. Diagrams must be co-ordinated and show all required interlocks etc. between systems or components.

E. Indicate with accurate dimensions, sizes and positions of all plant, equipment and valves together with all inspection points and test positions. All plants to have indicated manufacturer's name, model and type number also cross-referenced to maintenance manual.

F. Fully indicate all ductwork, pipework, sizes and positions of all plant equipment and valves together with all inspection points and test positions. All plant to have indicated manufacturer's name model and type number also cross-referenced to maintenance manual.

G. Show the disposition and depth of all cables, pipes, ducts, buried direct in the ground and taken at intervals where cable increase or decrease in number/size and at every point where the services enter into or depart from ducts or buildings.

H. Indicate the number, sizes and services for every cable, duct, and pipe, for every service within each building. Circuit lists for every distribution board shall be entered on to the relevant drawings and such lists shall agree with the list fixed within the distribution board door.

I. Show clearly on site drawings all the new buildings together with all other existing buildings and other permanent features with dimensions between such buildings

J. Cables, pipes, ducts, etc. clearly marked, together with installed backfill and

surround to each services.

K. Show clearly all plumbing and drainage and setting out dimensions for all drainage pipe work and manholes both within the building throughout the site, together with drainage pipe work backfill, or surround in each location. A schedule shall be included to indicate each manhole size, cover size, invert level and ground level.

L. The symbol used for each service for all as built drawings shall be shown on separate drawings.

M. In order to achieve accurate as built drawings, all relevant information relating to the mechanical works shall be entered onto prints supplied immediately after the work has been carried out. The marked up prints shall be available for inspection at the Contractor's site office at any reasonable time during the progress of the works.

N. All service routes, intersections and joints shown on the prints and finally recorded shall be actually physically measured from permanent features and accurate distances shall be shown on the Drawings.

O. In addition to the ”as built drawings”, the Contractor shall obtain and provide two sets of all manufacturers’ detailed drawings for all items of plant, equipment, apparatus and materials. These drawings shall be suitably titled and have drawing reference numbers added.

P. The Contractor shall provide two copies of all “as built drawings” for review comments and approval. Upon receiving approval in writing from the Engineer,

Q. on his representative, the Contractor shall provide one negative copy of each approved as built drawing and bind one set of prints into each of 6 No.(Hard and soft on CD) copies of the operating instructions specified in clause 1.25.

1.24 OPERATING AND MAINTENANCE INSTRUCTIONS

A. The working, operating and maintenance instruction shall be prepared in draft as soon as the working drawings are in hand as the work progresses and shall take the form of a manual in which fully detailed information relating to the maintenance and operation of the complete installation and its component parts is presented.

B. Overall general description of the complete equipment installed together with the method of functioning.

C. Full technical descriptions of each and every item of equipment, including the electrical circuit details as applicable.

D. Operating procedures for each section of the works and each individual item of equipment or plant.

E. Planned maintenance schedules for the installation and its component parts to include commissioning performance details and measurements.

F. Schedule of components comprising each and every item of equipment including manufacturer's name, description and part number of each

component.

G. A copy of the manufacturer's literature, describing each item of equipment, plant fittings and accessory type used throughout the installation. This literature shall list the technical data available, together with catalogue list numbers for replacement purposes.

H. Complete name of manufacturer, postal address, contact person telephone, telefax and E mail shall be tabulated for ease in procurement of spare parts. Spare parts forms (standard) shall be prepared.

I. Generally all drawings must be arranged to flood out from their position and be entirely visible when any part of the manual is being read. They shall be printed on linen-backed paper.

J. Each section shall be encased in a loose-leaf ring binder covered in plastic material of an approved colour and of a type that shall be flat when open.

K. The Contractor shall include for the preparation and supply of six copies of the above operating and maintenance instructions for each section after the Engineer has approved all details.

L. Electronic transfer of "As Built" drawings shall be provided as required by the Engineer.

1.25 INSTRUCTION AND TRAINING

I. The Contractor shall be responsible for the provision of suitably qualified personnel for the instruction and supervision of the Employer's staff at Site in the operation and routine maintenance of all mechanical equipment and associate works.

II. The Contractor shall provide a fully working and completely documented electronic planned preventative maintenance schedule (PPM). The PPM shall contain all the recommendations of the individual manufacturers of the equipment installed and recognised good practice, along with training of the Clients staff.

END OF SECTION 15010

SECTION 15060

HANGERS, SUPPORTS AND FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Mechanical supports and hangers.
2. Expansion slides and compensators.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Sleeves.
7. Mechanical sleeve seals.
8. Fire stopping relating to mechanical work.

1.2 DEFINITIONS

A. Fire stopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to applicable code FM UL WH for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.4 SUBMITTALS

A. Shop Drawings: Indicate layout for all mechanical and electrical systems with location including critical dimensions, sizes, forall hangers and supports locations and details ,sizes ,numbers of hangers and supports shall be certified by the manufacturer or his representative .

B. Product Data:
1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Design Data: Indicate load carrying capacity of trapeze, multiple, and riser support hangers. Submit calculations used to determine load carrying capacity of each type of support and hanger for the engineer's approval.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.
   2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.6 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MECHANICAL SUPPORTS AND HANGERS

A. All installation material used for supporting and fixing mechanical piping and ducting systems shall be of a modern type that gives tested reliable supporting solution without the need for welding, drilling or subsequent galvanizing for corrosion protection.

B. The mechanical supporting and hanging system shall consist of the following components:
   1. C-Channels shall be used as the main item for supporting all pipes and duct work. C-Channels shall be constructed of rolled galvanized steel strip with galvanization thickness of 20 microns. Contractor must submit mechanical drawing showing all support locations combined with detailed load calculation. Where the channel is cut, suitable end caps shall be used to protect the cut from corrosion. C-Channels of minimum thickness of 2mm and width of 40mm shall be used for all applications, and the height to be selected according to load calculation.
   2. C-Channel accessories as recommended by the channel manufacturer, shall be used to assemble various channel structures as appropriate for the application. These accessories include single-part components for attaching connectors, fixing nuts with serration, angles, brackets and pipe ring saddles. All parts shall be made of galvanized steel.
   3. Pipe Ring Clamps: For chilled water pipes and, cold domestic pipes; galvanized, pre-engineered pipe ring clamps should be used

for fixing all pipes to channel system or directly to the correct structure. The contractor shall verify that the pipe supported weight does not exceed the recommended maximum load of the clamp as provided by manufacturer. The pipe rings should be of a double screw type. Medium duty pipe rings shall be used for pipes up to 80mm diameter and heavy duty pipe rings shall be used for sizes 100mm and above except for the fire fighting system, the vertical pipes shall be supported by heavy duty double screw pipe rings without rubber and shall be UL listed. All pipe rings used for copper pipes and hot-chilled water steel pipes should be provided with a pre-fitted rubber inlay. Rubber inlay shall be made of EPDM material inspected for sound insulation with temperature resistance range -40 to 110°C.

4. Threaded rods shall be manufactured of steel grade 4.6. Rods, nuts and flat washers shall be clean threaded and flawless galvanized conditions.
5. Concrete anchors: shall be internally threaded for fixing rods, made of galvanized zinc plated and passivated steel. Anchor shall have FM, VDS and fire resistance approval. Zinc plated and passivated steel bolt anchor with suitable diameter should be used for fixing channels into concrete. Furnish calculations to substantiate selected sizes.
6. Duct work supports: Pre-manufactured C-Channels shall be used as the main item for supporting ducts. Supports for vertical duct shall be located to coincide with the individual floor slabs subject to a maximum spacing of 4 meters.

2.2 EXPANSION SLIDES

A. Furnish thermal expansion sliding elements and anchors for hot water , chilled water and steam pipes to prevent build-up forces at the pipe clamp and the fixing points. The glider shall provide sufficient slide way distance according to the manufacturer load limit and movement limit. Provide thermal expansion calculations for all net works with selection and installation details for the engineer's approval.

B. For pipe risers furnish special fabricated steel arms supported on slabs as cantilever and to be welded on pipe sides to hold the pipe weight. Provide manufacturer's details for the engineer's approval.

2.3 INSERTS

Furnish inserts with malleable iron case, galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

A. Metal Flashing: 0.7 mm thick galvanized steel.

B. Metal Counterflashing: 0.8 mm thick galvanized steel.

C. Flexible Flashing: 1.2 mm thick sheet compatible with roofing.

D. Caps: Galvanized steel 0.8 mm minimum; 1.5 mm at fire resistant elements.

2.5 EQUIPMENT CURBS

A. Concrete curbs are to be provided as recommended by manufacturer of equipment.

2.6 SLEEVES

A. Sleeves for Ø up to 100 mm DiaPipes Through Floors & Wet Floors: sleeves shall be steel pipe with extension of 25 mm above finish floor level, and clearance between pipes and sleeves shall be 1 inch and to be filled with approved mechanical sleeve seals or fire stop material (Fire walls &floors).

B. Sleeves for Ø above 100 mm Dia Pipes Through Floors & Wet Floors: sleeves shall be 1.2 mm thick galvanized steel with extension of 25 mm above finish floor level, and clearance between pipes and sleeves shall be 2 inchs and to be filled with approved mechanical sleeve seals or fire stop material (Fire walls &floors) .

C. Sleeves for Ø up to 100 mm Dia Pipes Through Beams, Walls, Footings: sleeves shall be steel pipe with 1 inch clearance between pipes and sleeves and to be filled with approved mechanical sleeve seals or fire stop material (Fire walls & floors) .

D. Sleeves for Ø above 100 mm Pipes Through Beams, Walls, Footings: sleeves shall be 1.2 mm thick galvanized steel with 1 inch clearance between pipes and sleeves and to be filled with approved mechanical sleeve seals or fire stop material (Fire walls & floors)

E. Sleeves for Round Ductwork: Galvanized steel.

F. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

2.7 MECHANICAL SLEEVE SEALS

A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.8 FIRESTOPPING

A. Definition: Fire stopping material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, water and hot gases through penetrations in fire rated wall and floor assemblies.
B. Performance Requirements: Provide firestopping systems which have been manufactured and installed to maintain performance criteria stated by manufacturer without defects, damage or failure.

C. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary experience, staff, and training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
D. Compliance: Comply with manufacturer's product data including product technical bulletins, product catalog installation instructions and product carton instructions.

E. Application of fire stop systems:
    1. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical bus ways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.(gaps between sleeves and the passage duct ,pipe,…etc)
    2. Slot gaps between edge of floor slabs and curtain walls.
    3. Openings between structurally separate sections of wall or floors.
    4. Gaps between the top of walls and ceilings or roof assemblies.
    5. Expansion joints in walls and floors.
    6. Openings and penetrations in fire-rated partitions or walls containing fire doors.
    7. Openings around structural members which penetrate floors or walls.
    8. Multiple electrical boxes located within the same stud cavity.

F. Firestopping materials: The following materials are listed for guidance for the types of firestopping materials required for the installation. The contractor shall add to the list at no extra charge further materials if found necessary to complete the installation or if required by the fire authority:
    1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
    2. Foam Firestopping Compounds: Multiple component foam compound.
    3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
    4. Fiber Stuffing and Sealant Firestopping: Composite of ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
    5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet

stainless steel jacket, joined with collars, penetration sealed with flanged stops.

6. Intumescent Firestopping: Intumescent putty, collars and sealant compound which expands on exposure to surface heat gain.
7. Firestop Pillows: Formed mineral fiber pillows.
8. Flexible joint spray.
9. Trowelable firestop compound.
10. Cast in-place firestop device.
11. Equivalent products listed in the U.L fire resistance directory.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Verify openings are ready to receive firestopping.

3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Obtain permission from Engineer before using powder-actuated anchors.

D. Do not drill or cut structural members.

E. Obtain permission from Engineer before drilling or cutting structural members.

F. Firestopping Surface Preparation: Prepare surface to receive firestop system products in accordance with manufacturer’s instructions for surface preparation.

1. Verify penetrations are properly sized and in suitable condition for application of materials.
2. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
3. Do not proceed until unsatisfactory conditions have been corrected.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 100 mm and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.1.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 13 mm space between finished covering and adjacent work.

D. Place hangers within 300 mm of each horizontal elbow.

E. Use hangers with 38 mm minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 1.5 m maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated hangers and supports for copper piping .

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 15080.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete as detailed on drawings or a minimum 150 mm thick and shall be 100 mm above finished floor level and extending 150 mm beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members or formed steel channel or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 15070.

3.6 INSTALLATION - FLASHING

A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 75 mm minimum above finished roof surface with lead worked 25 mm minimum into hub, 200 mm minimum clear

on sides with 600 x 600 mm sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

C. Flash floor drains in floors with topping over finished areas with lead, 250 mm clear on sides with minimum 910 x 910 mm sheet size. Fasten flashing to drain clamp device.

D. Seal floor drains watertight to adjacent materials.

E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.

F. Provide curbs for mechanical roof installations 350 mm minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

G. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 25 mm above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing or firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install stainless steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.

D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.

E. Remove dam material after firestopping material has cured.

F. Fire Rated Surface:
   1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
      a. Install sleeve through opening and extending beyond minimum of 25 mm on both sides of building element.
      b. Size sleeve allowing minimum of 25 mm void between sleeve and building element.
      c. Pack void with backing material.
      d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
   2. Where cable tray, bus, cable bus, conduit, wireway, and trough, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

G. Non-Rated Surfaces:
   1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
      a. Install sleeve through opening and extending beyond minimum of 25 mm on both sides of building element.
      b. Size sleeve allowing minimum of 25 mm void between sleeve and building element.
      c. Install type of firestopping material recommended by manufacturer.
   2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
   3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
   4. Interior partitions: Seal pipe penetrations at computer rooms, telecommunication rooms data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.9 FIELD QUALITY CONTROL

A. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

A.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Galvanized Steel Threaded	15 – 25	8mm	1.2
	32	8mm	1.6
	40 – 50	8mm	1.9
	65– 108	10mm	2.2
	125	10-12mm	2.5
	150	10-12mm	2.6

B.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Black Steel Seamless Welded or Grooved	15	8mm	1.6
	20 – 32	8mm	2.0
	40 – 65	8mm	2.7
	80	10mm	4.5
	100	10mm	5
	125 – 150	10-12mm	6
	200 – 300	12-16mm	7

C.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Copper	8 -12	8mm	1.0
	15 - 20	8mm	1.3
	25 - 40	8mm	1.7
	50	8mm	2.2
	65 - 80	10mm	3.3
	100	10-12mm	4.0

D.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
Cast Iron	40	8mm	1.5
	50	8mm	1.5
	75	10mm	1.5
	100	10mm	1.5
	150	10-12mm	1.5

E.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
PVC	40	8mm	1.5
	50	8mm	1.5
	75	10mm	1.5
	100	10mm	1.5
	150	10-12mm	2.0

F.

PIPE MATERIAL	PIPE SIZE (mm)	THREADED ROD DIA.	MAXIMUM HANGER SPACING (m)
PP-RCT	40	8mm	1.5
	50	8mm	1.5
	75	10mm	1.5
	100	10mm	1.5
	150	10-12mm	2.0

END OF SECTION 15060

SECTION 15070

MECHANICAL SOUND, VIBRATION AND SEISMIC CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Inertia bases.
2. Vibration isolators.
3. Duct silencers.
4. Cross-talk silencers.
5. Ductwork lagging.
6. Acoustical louvers.
7. Floating Floor.

1.2 PERFORMANCE REQUIREMENTS

A. All mechanical electrical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. All piping and ductwork located in mechanical equipment rooms, and for a minimum of 15m, whichever is greater, from any connection to vibration isolated mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration hangers.

C. All isolators shall provide the required static deflection related to the equipment weight or the operational speed as indicated below.

D. Provide minimum static deflection of isolators for equipment as follows:
1. Basement, Under 15 kW
   a. Under 400 rpm: 30 mm
   b. 400 - 600 rpm: 25 mm
   c. 600 - 800 rpm: 12 mm
   d. 800 - 900 rpm: 5 mm
   e. 1100 - 1500 rpm: 4 mm
   f. Over 1500 rpm: 3 mm
2. Basement, Over 15 kW
   a. Under 400 rpm: 60 mm
   b. 400 - 600 rpm: 50 mm
   c. 600 - 800 rpm: 25 mm
   d. 800 - 900 rpm: 12 mm
   e. 1100 - 1500 rpm: 5 mm
   f. Over 1500 rpm: 4 mm
3. Upper Floors, Normal
   a. Under 400 rpm: 100 mm
   b. 400 - 600 rpm: 90 mm
   c. 600 - 800 rpm: 50 mm
   d. 800 - 900 rpm: 25 mm

e. 1100 - 1500 rpm: 12 mm
f. Over 1500 rpm: 5 mm

4. Upper Floors, Critical
   a. Under 400 rpm: 120 mm
   b. 400 - 600 rpm: 100 mm
   c. 600 - 800 rpm: 90 mm
   d. 800 - 900 rpm: 50 mm
   e. 1100 - 1500 rpm: 25 mm
   f. Over 1500 rpm: 12 mm

E. Consider upper floor locations critical unless otherwise indicated.

F. Use concrete inertia bases for fans having static pressure in excess of 0.85 kPa or motors in excess of 30 kW, and on all base mounted pumps over 7.5 kW.

G. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

H. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook. HVAC Applications
1. Guest Rooms: 35 (on medium speed)
2. Halls, Corridors, lobbies: 40
3. Offices: 40
4. Restaurant: 40
5. Meetings rooms: 35
6. VIP offices: 35
7. Shops: 45
8. Back of house: 45
9. Car park: 50

1.3 SUBMITTALS

A. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each equipment and system. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.

B. Product Data: Submit schedule of vibration isolator type with location and load. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

C. Design Data: Submit calculations indicating maximum room sound levels are not exceeded. Furnish calculations to substantiate the selection of vibration and noise isolators and sound attenuators for the engineer's approval. Indicate spring diameters, free operating and solid height, ratio of horizontal and vertical stiffness and other required data to meet the system requirements.

D. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.

E. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.

F. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

G. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design application of duct silencers acoustic housings seismic snubbers under direct supervision of Professional Engineer experienced in design of this Work.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 INERTIA BASES

Concrete Inertia Bases:

1. Mass: Minimum of 1.5 times weight of isolated equipment.
2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, concrete filled.
3. Connecting Point: Reinforced to connect spring isolators and snubbers to base.
4. Concrete: Reinforced 20 MPa concrete.
5. Machine shall be fixed to the base with grouted-in holding down bolts.

2.2 VIBRATION ISOLATORS

A. Open Spring Isolators:

1. Spring Isolators:
   a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
   b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection and 50% overload capacity.
3. Spring Mounts: Furnish with leveling devices, minimum 6 mm thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 1.2 mm; meet requirements for neoprene pad isolators.

B. Restrained Spring Isolators:
1. Spring Isolators:
   a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 6 mm thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 1.2 mm; meet requirements for neoprene pad isolators.
5. Restraint: Furnish welded steel housing assemblies to limit vertical movement of the supported equipment.

C. Closed Spring Isolators:
1. Spring Isolators:
   a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 7 mm clearance.

D. Restrained Closed Spring Isolators:
1. Spring Isolators:
   a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
   b. Code: Color code springs for load carrying capacity.
2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 7 mm clearance and limit stops.

E. Spring Hanger:
   1. Spring Isolators:
      a. Furnish hot dipped galvanized housings and epoxy powder coated springs.
      b. Code: Color code springs for load carrying capacity.
   2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
   3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
   4. Misalignment: Capable of 20 degree hanger rod misalignment.

F. Neoprene Pad Isolators:
   1. Rubber or neoprene-waffle pads.
      a. 30 durometer.
      b. Minimum 13 mm thick.
      c. Maximum loading 275 kPa.
      d. Height of ribs: not to exceed 0.7 times width.
   2. Configuration: 13 mm thick waffle pads bonded each side of 6 mm thick steel plate.

G. Rubber Mount or Hanger: Molded rubber designed for 13 mm deflection with threaded insert.

H. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber bonded to a steel load transfer plate and formed steel bolt down bracket with anti-short circuit neoprene grommet to prevent metal to metal contact.

I. Seismic Snubbers:
   1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
   2. Neoprene Elements: Replaceable, minimum of 18 mm thick.
   3. Capacity: 4 times load assigned to mount groupings at 10 mm deflection.
   4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

J. Seismic Restraint for ceiling suspended equipment:
   1. Seismically support all suspended equipment above 200kg weight by seismic springs. Type and quantity to unit load. Furnish calculations for the engineer's approval.
   2. Seismically restrain all suspended equipment above 200kg weight. Use Type J aircraft Cable Restraints for all corners.
   3. Type J cable seismic restraint sizes, quantities, locations, and mounting details shall be as per ASHRAE and or SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.) "Seismic Restraint Manual Guidelines for Mechanical Systems", Second Edition

2.3 DUCT SILENCERS

A. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Configuration: Rectangular with lined splitters with radius nose and contoured tails.

C. Materials:
   1. Outer Casing: Minimum 0.9 mm thick galvanized steel stiffened with welded seams, 50 mm long, 2.9 mm slip joints on both ends.
   2. Inner Casing and Splitters: Minimum 0.6 mm thick perforated galvanized steel.
   3. Fill: Glass fiber or mineral wool of minimum 64 kg/cu m density.
   4. Fill Liner: Bonded glass fiber matting.

D. Rating:
   1. ASTM E477 Insertion Loss and Maximum Generated Noise at 20 m/sec Face Velocity to meet space noise level criteria.
   2. Static Pressure Drop at 10 m/sec Face Velocity: 0.075 kPa.
   3. Air Tight Static Pressure: 2.5 kPa.

E. Performance: Achieve noise reduction as required to meet space noise level criteria.

2.4 CROSS-TALK SILENCERS

A. Description: Duct sections with sheet metal outer casing, sound absorbing fill material; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Configuration: Rectangular, lined with splitters with radius nosed and contoured tails.

C. Materials:
   1. Outer Casing: Minimum 0.8 mm thick galvanized steel with mastic filled lock formed seams, 75 mm long, 2.9 mm slip joint on both ends.
   2. Inner Casing and Splitters: Minimum 0.6 mm thick perforated galvanized steel.
   3. Fill: Glass fiber or mineral wool of minimum 64 kg/cu m density.
   4. Fill Liner: Bonded glass fiber matting.

D. Rating:
   1. Static Pressure Drop at 5 m/sec Face Velocity: 0.050 kPa.

2.5 DUCTWORK LAGGING

A. Acoustic Insulation: 19 mm thick elastomeric, closed cell rubber. Fixing with fire proof adhesive and mechanical fixing with self welding pins and galvanized steel washers.

2.6 ACOUSTICAL LOUVERS

A. Configuration: 200 mm deep louvers with blades on 45 degree slope; sound absorbing fill material, and inner surface of perforated sheet metal, channel frame, bird Screen.

B. Materials:
1. Louvers: 2.50 mm extruded aluminum, welded assembly, with factory color anodized finish.
2. Inner Surface: Minimum 0.6 mm thick perforated galvanized steel.
3. Fill: Glass fiber or mineral wool of minimum 64 kg/cu m density.
4. Fill Liner: Bonded glass fiber matting.
5. Bird screen: 13 mm square wire mesh.
6. Mounting: Exterior angle flange. Screw holes in jambs.

C. Rating:
1. Insertion loss:
Provide manufacturer data to meet space noise level criteria.

2. Static Pressure Drop at 1.5 m/sec Face Velocity: 0.030 kPa.

2.7 FLOATING FLOOR

A. Proprietary floating floor systemshall be used for chillers, pumps, boilers, large condensing units and air handling units as indicated on drawings.

B. The floating floor shall consist primarily of an isolated concrete slab 100mm minimum thickness (2400 kg/m³) supported by sound isolated material of pre-molded fiberglass pads. The perimeter of the floating floor shall be isolated from adjoining walls, columns or curbs by means of perimeter isolation board of closed cell, expanded polyethylene, 20mm thick.

C. Support media “Noise and Vibration Pads” must provide a natural frequency of 10-15Hz or lower and shall remain constant within 2Hz over the entire load range of the floor system. Pads shall be designed to withstand a minimum imposed load of 200 PSF in all open areas, and shall have a minimum overload capacity of 100% in all high load areas. Pads shall be resistant to oil, water, acids and fungus.

D. Design: Provide full calculation for the isolation-floating floor showing loads, deflections. dimensions, material specifications and concrete reinforcement. Calculations shall be submitted for each area where this system is shown on drawings.

E. Carefully examine conditions at the job site before commencing work. Any surfaces not properly prepared to receive the work of this section shall be reported to the Engineer.

F. Shop drawings: full set shall be prepared for all areas and submitted for approval prior to commencement of work. Drawings shall show the construction of the various parts of the work. Including connections of the isolation system components to adjacent parts of the building structure.

G. Noise and vibration pads shall be surrounded by a mat of fiberglass having the same thickness of the pads. Pads shall be topped by a layer of plywood, 15mm thick, concrete pouring form. Plywood shall be covered by 150 micron polyethylene sheet prior to pouring concrete. Density of pads shall suit the equipment load and the concrete load.

H. Penetrations: piping, conduit or ductwork penetrations of the “floating floor” shall be isolated with 20mm, closed cell expanded polyethylene as specified for the perimeter isolation board.

I. Isolated floor drains: shall consist of two part units designed to be cast into the isolated slab and the structure slab with no rigid connection between the two members.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify equipment, ductwork and piping is installed before work in this section is started.

3.2 INSTALLATION

A. Support duct silencers rigidly to ductwork.

B. Install cross-talk silencers in wall. Calk wall penetrations.

C. Lag ductwork, where indicated by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork.

D. Attach ductwork to acoustic louvers with flexible duct connections. Refer to Section 15820.

E. Install isolation for motor driven equipment.

F. Bases:
   1. Set steel bases for 25 mm clearance between housekeeping pad and base.
   2. Set concrete inertia bases for 50 mm clearance between housekeeping pad and base.

G. Adjust equipment level.

H. Install spring hangers without binding.

I. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

J. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

K. Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

L. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 1.5 mm maximum clearance. Provide other snubbers with clearance between 4 mm and 7 mm.

M. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector. as follows:
1. Up to 100 mm Diameter: First three points of support.
2. 125 to 200 mm Diameter: First four points of support.
3. 250 mm Diameter and Over: First six points of support.
4. Select three hangers closest to vibration source for minimum 25 mm static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 25 mm static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

B. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

C. Furnish services of a third party testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

END OF SECTION 15070

SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates.
   2. Tags.
   3. Stencils.
   4. Pipe markers.
   5. Ceiling tacks.
   6. Labels.
   7. Lockout devices.

1.2 SUBMITTALS

A. Product Data: Submit manufacturers catalog literature for each product required.

B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Samples: Submit two tags, labels, pipe markers suitably sized for the project.

D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.4 QUALITY ASSURANCE

A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

B. Maintain one copy of each document on site.

1.5 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.6 EXTRA MATERIALS

A. Furnish six containers of spray-on adhesive.

PART 2 PRODUCTS

2.1 NAMEPLATES

A. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Plastic Tags:
   1. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 38 mm square.

B. Metal Tags:
   1. Brass with stamped letters; tag size minimum 38 mm square with finished edges.

C. Information Tags:
   1. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 83 x 143 mm with grommet and self-locking nylon ties.

D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.3 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. Up to 51 mm Outside Diameter of Insulation or Pipe: 13 mm high letters.
   2. 64-150 mm Outside Diameter of Insulation or Pipe: 25-mm high letters.
   3. Over 150 mm Outside Diameter of Insulation or Pipe: 44 mm high letters.
   4. Ductwork and Equipment: 44 mm high letters.

B. Stencil Paint: As specified in Section 09900, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
   1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:
   1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:
   1. Bright colored continuously printed plastic ribbon tape, minimum 150 mm wide by 0.10 mm thick, manufactured for direct burial service.

2.5 CEILING TACKS

A. Description: Steel with 19 mm diameter color-coded head.

B. Color code as follows:
   1. HVAC equipment: Yellow.
   2. Fire dampers/smoke dampers: Red.
   3. Plumbing valves: Green.
   4. Heating/cooling valves: Blue.

2.6 LABELS

A. Description: Aluminum, size 48 x 19 mm, adhesive backed with printed identification and bar code.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Anodized aluminum hasp with erasable label surface; size minimum 184 x 76 mm.

B. Valve Lockout Devices:
   1. Steel device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09900 for stencil painting.

3.2 INSTALLATION

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Install underground plastic pipe markers 150 to 200 mm below finished grade, directly above buried pipe.

F. Install piping identification on chilled and heating water pipes.

G. Identify chiller, boiler, fan coil units air handling units, pumps, tanks, and fans with plastic nameplates.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify air terminal units with numbered tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 20 mm diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. Identify ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

N. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 15075

SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pressure gages.
2. Pressure gage taps.
3. Thermometers.
4. Thermometer supports.
5. Test plugs.
6. Static pressure gages.
7. Flexible connectors.
8. Diaphragm-type expansion tanks.
9. Air vents.
10. Air separators.
11. Strainers.
12. Flow controls.
13. Relief valves.

1.2 PERFORMANCE REQUIREMENTS

A. Flexible Connectors: Provide at or near pumps, compressors and motorized equipment where piping configuration does not absorb vibration.

1.3 SUBMITTALS

A. Product Data: Submit for manufactured products and assemblies used in this Project.
1. Manufacturer’s data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
4. Submit electrical characteristics and connection requirements.

B. Samples: Submit one unit of each of the above mentioned piping specialties.

C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of actual locations of components and instrumentation.

B. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.6 FIELD MEASUREMENTS

A. Verify field measurements before fabrication.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

A. Gage: ASME B40.1, UL 393 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
   1. Case: Stainless steel.
   2. Bourdon Tube: Type 316 stainless steel.
   3. Dial Size: 102 mm diameter.
   4. Mid-Scale Accuracy: 1/2 percent.
   5. Scale: Bar
   6. Dial: Glycerin submerged.

2.2 PRESSURE GAGE TAPS

A. Needle Valve: Stainless Steel, 6 mm NPT for minimum 2070 kPa.

2.3 STEM TYPE THERMOMETERS

A. Thermometer: ASTM E1, red or blue appearing mercury, lens front tube, cast aluminum case with enamel finish.
   1. Size: 178 mm scale.
   2. Window: Clear Lexan.
   3. Stem: Brass, 20 mm NPT, 89 mm long.
   4. Accuracy: ASTM E77 2 percent.
   5. Calibration: Degrees C.
   6. Range: Select to suit application with average reading in the middle.

2.4 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions, and with cap and chain.

B. Flange: 76 mm outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 TEST PLUGS

A. 6 mm NPT or 13 mm NPT stainless steel fitting and cap for receiving 3 mm outside diameter pressure or temperature probe with:
   1. Neoprene core for temperatures up to 93 degrees C.
   2. Nordel core for temperatures up to 176 degrees C.
   3. Viton core for temperatures up to 204 degrees C.

B. Test Kit:
   1. Carrying case, internally padded and fitted containing:
      a. Two 89 mm diameter pressure gages.
         1) Scale range: 0 to 15 Bar
      b. Two gage adapters with 3 mm probes.
      c. Two 200 mm dial thermometers.
         1) Scale range:0 to 50degrees C.
         2) Scale range: 0 to 100 degrees C.

2.6 STATIC PRESSURE GAGES

A. Dial Gages: 89 mm diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.

B. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full scale accuracy.

C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 6 mm diameter tubing.

2.7 FLEXIBLE CONNECTORS

A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 230 mm long; for maximum working pressure 2070 kPa. Threaded ends for sizes up to 50 mm diameter and flanged ends for sizes 65 mm diameter and larger.

2.8 DIAPHRAGM-TYPE EXPANSION TANKS

A. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 1600 kPa , with flexible EPDM diaphragm sealed into tank, and steel support stand.

B. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 80 kPa.

2.9 AIR VENTS

A. Float Type:
   1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.10 AIR SEPARATORS

A. In-line Air Separators: Cylindrical micro bubble deaerator for removing air from closed type water circuits of cooling and heating. The unit shall have internal copper mesh to change turbulent flow into laminar flow. Body made of Brass for sizes 40 mm and smaller, or steel for sizes 50 mm and larger; tested and stamped for 1000 kPa operating pressure. Temperature range 0-100°C. Flow speed 0-2 m/s. Furnish automatic air vent of brass construction with non-shutoff valve fixed on top of unit.

2.11 STRAINERS

A. Size 50 mm and Smaller:
   1. Screwed brass or iron body for 1600 kPa working pressure, Y pattern with 0.8 mm stainless steel perforated screen.

B. Size 65 mm to 100 mm :
   1. Flanged iron body for 1600 kPa working pressure, Y pattern with 1.2 mm stainless steel perforated screen.

C. Size 125 mm and Larger:
   1. Flanged iron body for 1600 kPa working pressure, basket pattern with 3.2 mm stainless steel perforated screen.

2.12 FLOW CONTROLS

A. Double Regulating Valve (DRV) **<** 50mm.
Body shall be made of Bronze to BS1400LG2 and/or DZR to BS 5154 Alloy B, Double Regulating Valve shall have measuring points of self-sealed and Removable cap. Female threaded ends to BS 21 (ISO 7), DRV shall be of Y Pattern Globe Type with Characterized Throttling Disk.Memory Lock by Allen Key, Pressure Rated PN20 from -20°C to 120°C.
Valve shall be selected so as to give ±6% accuracy (or better). Balancing procedure error should not exceed ±10% of the designed flow.

B. Double Regulating Valve (DRV) **>** 65mm.
Body shall be Made of Cast Iron to BS2789 (EN-GJL-250) or of Ductile iron to BS 2789 Gr 500/7 (EN-GJS-450-10) , Double Regulating Valve shall have measuring points of self-sealed and Removable cap, Grooved ends to ISO 4200, DRV shall be of Y Pattern Globe Valve with Characterized Throttling Disk., Memory Lock by Allen Key. Pressure Rated PN16 from -20°C to 120°C .

Valve shall be selected so as to give ±5% accuracy (or better). Balancing procedure error should not exceed ±10% of the designed flow.

C. Differential Pressure Valve (DPV)**<** 50mm.

Body shall be made of Bronze to BS1400LG2 and/or DZR to BS 5154 Alloy B, Differential Pressure Controller Valve shall have measuring points of self-sealed and Removable cap. Female threaded ends to BS 21 (ISO 7),setting shall be made by Allen Key with shut off capability , Pressure Rated PN16 from -20°C to 120°C .

Minimum Primary Differential Pressure 250 kPa.

DPV shall be selected so as to maximize the 2-way Control valve Authority, with minimum pressure drop, to give the design flow, and to deliver the actual Differential pressure to the Unit or group of Units.

When DPV is to control group of Units (branch connection) DPV shall be connected on the return line, DRV on the supply line, with capillary tube connected to the DRV, Connection of the capillary tube shall be on the primary or secondary (Before or after the DRV), according to the required Differential Pressure, Design Flow and selected DPV.

Size, place and number of DPV's to be used in the control of group of Units (branch connection) depends on the actual coil and 2-way control valve pressure drop.

When DPV is to control one Unit (Control Valve connection) DP shall be connected on the return line, DRV on the return line, 2-way Control Valve in between with capillary tube connected to the DRV, Connection of the capillary tube shall be on the primary or secondary (Before or after the DRV), according to the required Differential Pressure and selected DPV.

D. Differential Pressure Valve (DPV)**>** 65mm.

Body shall be Made of Cast Iron to BS2789 (EN-GJL-250), Differential Pressure Controller Valve shall have measuring points of self-sealed and Removable cap, Flanged to Flanges to BS EN 1092-2, Pressure Rated PN16from -10°C to 80°C .

Minimum Primary Differential Pressure 350 kPa.

DPV shall be selected so as to maximize the 2-way Control valve Authority, with minimum pressure drop, to give the design flow, and to deliver the actual Differential pressure to the Unit or group of Units.

When DPV is to control group of Units (branch connection) DPV shall be connected on the return line, DRV on the supply line, with capillary tube connected to the DRV, Connection of the capillary tube shall on the primary or secondary (Before or after the DRV), according to the required Differential Pressure, Design flow and selected DPV.

Size, place and number of DPV's to be used in the control of group of Units (branch connection) depends on the actual coil and 2-way control valve pressure drop.

When DPV is to control one Unit (Control Valve connection) DPV shall be connected on the return line, DRV on the return line, 2-way Control Valve in between with capillary tube connected to the DRV, Connection of the capillary tube shall be on the primary or secondary (Before or after the DRV), according to the required Differential Pressure and selected DPV.

2.13 RELIEF VALVES

A. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

PART 3 EXECUTION

3.1 INSTALLATION - THERMOMETERS AND GAGES

A. Install two pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping

C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage. Install siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 65 mm for installation of thermometer sockets. Allow clearance from insulation.

E. Install thermometers in air duct systems on flanges.

F. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

G. Locate duct-mounted thermometers minimum 3 m downstream of mixing-dampers, coils, or other devices causing air turbulence.

H. Coil and conceal excess capillary on remote element instruments.

I. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.

J. Provide instruments with scale ranges selected according to service with largest appropriate scale.

K. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

L. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Locate test plugs as indicated on Drawings.

B. Where large air quantities accumulate, provide enlarged air collection standpipes.

C. Install manual air vents at system high points.

D. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

E. Provide air separator at the inlet to chillers and outlet from boilers.

F. Provide drain and hose connection with valve on strainer blow down connection.

G. Support pump fittings with floor mounted pipe and flange supports.

H. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

I. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

J. Pipe relief valve outlet to nearest floor drain.

K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 15120

SECTION 15739

SPLIT SYSTEM AIR CONDITIONING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Indoor unit (indoor unit).
   2. Condensing unit. (outdoor unit)

1.2 SUBMITTALS

A. Product Data: Submit data indicating:
   1. Cooling and heating capacities.
   2. Dimensions.
   3. Weights.
   4. Rough-in connections and connection requirements.
   5. Electrical requirements with electrical characteristics and connection requirements.
   6. Controls.
   7. Accessories.

B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

C. Manufacturer's Certificate: Certify Products to meet specified requirements.

D. Manufacturer’s Field Reports: Submit start-up report for each unit.

1.3 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of controls installed remotely from units.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.4 QUALITY ASSURANCE

A. Performance Requirements:, Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.

B. Cooling Capacity: Rate in accordance with ARI 210/240.

C. Sound Rating: Measure in accordance with ARI 270.

D. Insulation and adhesives: Meet requirements of NFPA 90A.

E. Maintain two copies of each document on site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.6 COORDINATION

A. Coordinate installation of condensing units with concrete pad and roof structure.

B. Coordinate installation of air handling units with building structure.

1.7 GUARANTEE:

Split Air conditioning units shall be the latest and newest model and latest technology for the manufacturer products and shall include a two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including cleaning ,washing filters and outdoors condensers with water four times a year .(cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

Split Air conditioning units shall have a VALID EUROVENT CERTIFICATION.

PART 2 PRODUCTS

2.1 SPLIT SYSTEM AIR CONDITIONING UNITS (SACU)

A. Product Description: **Split system, heat pump inverter controlled type** to be suitable for operation from **-5°C ambient temperature up to 46°C ambient temperature** , consisting of indoor air handling unit and outdoor condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, electric heating coil, air filters, thermostat and controls, air handling unit accessories, condensing unit accessories, refrigeration specialties, and inter connecting refrigerant piping between

indoor and outdoor units including thermal insulation, control wiring and power cables.

2.2 CONDENSING UNIT (CU)

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.

C. Compressor: Single refrigeration circuit with inverter controlled compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to aluminum fins, factory leak and pressure tested.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.

F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.

G. Condensing Unit Accessories: Furnish the following accessories:
   1. Controls to provide freeze protection on evaporator.
   2. Time delay relay.
   3. Anti-short cycle timer.
   4. Disconnect switch.
   5. Vibration isolators of neoprene rubber.
   6. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.

H. Refrigeration specialties: Furnish the following for each circuit:
   1. Charge of compressor oil.
   2. Full charge of refrigerant.
   3. Shut-off valves on suction and liquid piping.
   4. Charging valve.
   5. Crankcase heater.
   6. Hot gas muffler.
   7. Pressure relief device.

I. Refrigerant: Furnish full charge of refrigerant R-410A or R-32

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2.3 CONTROLS

A. Thermostat: Remote space thermostat with single stage cooling and heating.

2.4 Wall Type

Modern style, extremely quiet in operation, long-life washable filters, vibration free.
1- Wall-mounted, impact-resistant, washable decoration panel.
2- Air suction through the panel, which has an integrated, long-life air filter
3- The air is discharged threw motorized air vanes.
4- Phase controlled multiple steps, vibration-free and quiet running.
5- Protected by a thermal contact.
6- Microprocessor temperature control.
7- Fan motor thermal protection.
8- Sound pressure not more than 45 dBA @ high speed.
9- Built in infra-red receiver with Wireless remote control.
10- Indoor and outdoor units shall be fully controlled by Master Centralized Controller.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify concrete pad for condensing unit is ready for unit installation.

3.2 INSTALLATION - CONDENSING UNIT

A. Install condensing units on vibration isolators.

B. Install units on concrete foundations or alternative painted steel base to raise unit 150mm above finished roof level.

C. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit.

D. Evacuate refrigerant piping and install full charge of refrigerant.

E. Install electrical devices furnished loose for field mounting.

F. Install control wiring and cables between air handling unit, condensing unit, and field installed accessories.

G. Install connection to electrical power wiring in accordance with electrical specifications.

3.3 MANUFACTURER'S FIELD SERVICES

A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.4 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install new cleanable filters in units at Substantial Completion.

3.5 DEMONSTRATION

A. Demonstrate A/C split unit operation and maintenance.

B. Demonstrate starting, maintenance, and operation of condensing unit including freeze protection on evaporator.

END OF SECTION 15739

SECTION 15837
FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. In-Line Centrifugal Fans.
   2. Twin Centrifugal Fans.
   3. Low Noise Mixed Flow Fans (Silent Fans).
   4. Roof Fans.
   5. Kitchen Exhaust Fans.
   6. Axial Fans.
   7. Smoke Extraction Fans.
   8. Jet Fans.
   9. Decorative Propeller Fans
   10. Bathroom decorative wall / Ceiling Propeller fan.
   11. Humidifier
   12. Air Purifire.
   13. Air Curtains

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on actual project site elevation above sea level.

B. Air performance for axial fans shall be according to ISO 5801 or equivalent.

C. Fire Rating: Where indicated on schedules of equipment,fans to be firerated 300°C/2hr.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Fan performance curves with system operating conditions indicated.
   2. Fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support

locations, type of support, and weight on each support. Indicate and certify field measurements.

D. Operation and Maintenance Data: For fans to include in emergency, operation, and maintenance manuals.

E. Selection data for each fan for approval before ordering.

F. Furnish and install as indicated on the drawings and plans, an in space centrifugal humidification system complete and ready to operate.

G. Furnish owner's manuals and blueprints covering installation, start up, maintenance and operating instructions, complete in every way to permit efficient operation and maintenance of the system.

H. Manufacturer's Data: submit manufacturer's product data including dimensions, sizes, weights, installation, instructions, storage, instructions, and code compliance reports.

1.5 QUALITY ASSURANCE

A. Material and equipment shall conform to the latest edition of applicable codes, European Norms and requirements of local authorities having jurisdiction.

B. Manufacturers: Firms regularly engaged in manufacture of all Fans types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.

C. The Agent or Authorized Dealer should be representing directly the manufacturer, a formal letter should be issued in the name of the Agent or Authorized Dealer directly from the manufacturer.

D. The Agent or Authorized Dealer should be registered in Jordan for not less than 5years, and should have experience in selling, installing and maintaining Fans systems in Jordan.

Guarantee: Fans shall be the latest and newest model and latest technology for the manufacturer products and shall include a (2) two years full guarantee, full warranty and full preventive maintenance on all parts and labor after acceptance by the Engineer and the owner including regular visits two times a year and upon request (cost of spare parts ,labor and regular visits and upon request deemed to be included in the contractor's cost for the two years after acceptance) .

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 EXTRA MATERIALS

A. Furnish two sets of belts for each belt-driven unitthat match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.9 WARRANTY

A. General Warranty: the special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace any axial fan or component that do not meet requirements or that fail within the specified warranty period.

1. Warranty period: 2 years from date of Substantial Completion for any component of the fans.

PART 2 - PRODUCTS

2.1 GENERAL FAN REQUIREMENTS

A. General
1. Performance data for all fans and spare parts shall be determined in accordance with the provisions of ISO 5801 and AMCA 210 or equivalent.
2. Sound pressure level ratings of ducted fans shall comply with ISO3744or equivalent.
3. Sound pressure level ratings of non-ducted fans shall comply with ISO 3744 or equivalent.
4. Safety provisions for power transmission equipment and non-ducted inlets and outlets shall include guards and screens, unless other provisions are required, and shall be constructed in accordance with applicable provisions of ASME; Installation shall be such that fan vibration-isolation provisions are not negated.
5. Fan wheels shall be statically and dynamically balanced at the factory according to ISO 1940-1 grade G6.3.

B. Corrosion Protection: All steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint.

2.2 INLINE CENRIFUGAL FANS

A. Description: fully factory fabricated-assembled-tested and finished belt or direct drive with galvanized steel housing lined with acoustic insulation, removable side panel for access, inlet and outlet duct collar, gravity back draft damper in discharge, horizontal hanging brackets.

B. Wheel: backward or forward inclined centrifugal type statically and dynamically balanced.

C. Motor and Drive Mounting: Within air stream.

D. Motor: totally enclosed air over motor IEC rating, class F insulation and IP55 protection mounted on vibration isolators.

E. Direct-drive Units: Motor encased in housing, factory or field wired to disconnect located on outside of fan housing.

F. Bearings: shall be air handling quality, heavy duty, pillow block type. Bearings shall be selected for a basic rating life L10 of 100,000 hours.

G. Performance: Refer to schedules on the drawings

H. Electrical Characteristics and Components:
   1. Electrical Characteristics: In accordance with related sections in Division 16.
   2. Refer to Electrical drawings and schedules for related electrical data.

2.3 TWIN FANS

A. Configuration: fully fabricated-assembled- tested- finished and lined box fitted with two forward facing centrifugal fans for independent working, each unit fitted with factory mounted back draft damper complete with auto-change over electrical panel, the electrical panel should suitable for outdoor mounting and dust proof with IP56 and suitable for BMS interface.

B. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, integral inlet and outlet duct collar

C. Wheel: Centrifugal forward curved type constructed of galvanized steel.

D. Motor: totally enclosed air over motor IEC rating, class F insulation with external rotor, incorporated thermal protector, ball bearings and IP54 protection.

E. Working temperature -20 to +60 °C.

F. Mounting brackets on the base make installation easier.

G. Performance: Refer to schedules on the drawings.

2.4 SILENT FANS.

A. Description: direct-drive mixed flow fans, as indicated, consisting of housing, wheel, fan shaft, motor with durable ball bearing, and hangers.

B. Housings: Heavy Galvanized steel sheet with anticorrosive polymer coating.

C. Fan wheel: GI, FRP, plastic wheel with mixed flow blades.

D. Acoustical: Thermal and acoustic insulation with ROCKWOOL; and Internal perforated casing to facilitate noise absorption.

E. Operating temperature: -10ºC +60ºC.

2.5 ROOF FANS.

A. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings to be an average life of 100,000 hours, motor and field mount disconnect switch, drive assembly, curb base and accessories.

B. Housings: Removable, sheet steel rain deflector hood with anticorrosive protection, with sheet steel base plate; square, one piece, base with venture inlet cone, discharge baffle to direct discharge air downward and protection guard.

C. Fan wheels: galvanized steel wheel with backward inclined blades, airfoil or axial blade.

D. Belt Driven Drive Assembly: Resiliently mounted to the housing, with the following features:
   i. Fan shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
   ii. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings of average life shall not be less than 100,000 hours.
   iii. Pulleys: Cast iron, adjustable-pitch motor pulley.

E. Motor: totally enclosed air over motor IEC rating, class F insulation IP54 protection, fully coved by fan housing.

2.6 KITCHEN EXHAUST FANS

A. Application: Roof mounted fan especially designed for removal smoke and grease laden working at continuous air stream temperature +120°C and fire rated 400°C/2hr according to EN 1210.

B. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings to be an average life of 200,000 hours, motor and field mount disconnect switch, drive assembly, protection guard, curb base and accessories

C. Housings: Removable, aluminum rain deflector hood, with galvanized sheet steel base plate; square, one piece, base with venture inlet cone.

D. Fan wheels: galvanized steel wheel with backward inclined blades.

E. Belt Driven Drive Assembly:
   1. Resiliently mounted to the housing, with the following features:
   2. Fan shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings of average life shall not be less than 200,000 hours.
   4. Pulleys: Cast iron, adjustable-pitch motor pulley.

F. Motor: totally enclosed air over motor IEC rating, class F insulation IP55 protection, fully coved by fan housing and totally isolated form exhaust air stream.

2.7AXIAL FANS

A. Description: direct-drive axial fans as indicated, consisting of fan blades, hub, housing, motor, and accessories.

B. Casing: fan casing shall be heavy gauge, sheet steel, roll formed, welded and hot dipped galvanized after fabrication to BS EN ISO1461:2009 with flanged edges and with baked-enamel anticorrosive finish coat or equivalent and shall be cover all fan's components.

C. Fan Impeller: adjustable pitch airfoil section impeller with cast aluminum blades

D. Fan Hub: high quality cast aluminum.

E. Incorporate integral mounting flanges with industry standard drillings, to allow the rear of the platform mounted motor to partially protrude beyond the flange.

F. Motor: totally enclosed air over motor or fan cooled IEC rating, class F insulation IP55 protection, working temperature -20 to +50 °C, motor shall be wired weather proof cable to IP55 protected terminal box mounted on the outside of the fan casing.

G. Accessories: The following accessories are required as indicated:
   1. Gravity Shutters: Aluminum gravity damper.
   2. Mounting Brackets.
   3. Vibration Isolators.
   4. Protection guard.

2.8 SMOKE AXIAL EXTRACTION FANS.

A. Description: direct-drive fire rated 300°C/2hr axial fan according to EN 1210, and approved by Civil Defense, consisting of fan blades, hub, housing, motor, and accessories.

B. Casing: fan casing shall be heavy gauge, sheet steel, roll formed, welded and hot dipped galvanized after fabrication to BS EN ISO1461:2009 with flanged edges and with baked-enamel anticorrosive finish coat or equivalent and shall be cover all fan's components.

C. Fan Impeller: adjustable pitch airfoil section impeller with cast aluminum blades

D. Fan Hub: high quality cast aluminum

E. Incorporate integral mounting flanges with industry standard drillings, to allow the rear of the platform mounted motor to partially protrude beyond the flange.

F. Motor: totally enclosed air over motor (TEAO), class H insulation IP55 protection, working temperature -20 to +50 °C, motor shall be wired fire resistance cable to IP55 protected terminal box mounted on the outside of the fan casing.

2.9 JET FANS

A. Description: single direction, 2 speed impulsion fan with two silencer, deflector, and brackets, certified for smoke extraction according to EN 12101 300 °C/2hrs

B. Casing: Heavy gauge sheet steel, roll formed, hot dipped galvanized after fabrication, with integral 4 points mounting feet allow unit to be mounted easily.

C. Fan Impeller: cast aluminum designed for optimum thrust as indicated, hub made of pressure die cast aluminum.

D. Silencer: integral inlet and outlet silencer mounted in the either side of the fan housing, with an integral bell mouth to reduce sound level and optimal performance. Silencer shall be constructed of outer galvanized steel sheet and per-galvanized perforated sheet inner lining, Inlet silencer fitted with zinc plated guard and the outlet silencer fitted with deflector to guide the air in the requested direction.

E. Motor: totally enclosed air over motor class H insulation, with ball bearing and IP55 protection.

2.10 DECORATIVE PROPELLER FANS

A. Decorative fans for wall-mount, ceiling mount and window mount applications.

B. High performance impeller and durable ABS plastic housing decorative type, low noise design.

C. High performance impeller and long life bearing for an average life time of 60,000 hours.

D. Fans equipped with louver and durable automaticor gravity shutter.

2.11 BATHROOM DECORATIVE WALL/CEILING PROPELLER FAN

A. The bathroom propellers should be 50 cycle, 230 Volt unit for wall/ceiling mounting with a high performance axial impeller and durable ABS white plastic housing decorative type. The Motor ambient temperature should be at least 40 degrees C.

B. Fan should be equipped with automatic shutter.

C. Fan sound level should not exceed 38-42 dB(A) at 3m.

2.12 Humidifier

A. Humidifier shall be optimum humidity distribution.

B. Humidifier shall have Electronic water level detector.

C. Humidifier shall have Electronic overflow detector.

D. Humidifier shall have Silver ionizing

E. Humidifier shall have Filter set for air cleaning

F. Humidifier shall have Water connection

G. Humidifier shall have Control via radio hygrostat

H. Brackets for installation on walls/floors.

I. Unit shall have water reservoir which includes float valve to automatically regulate water level.

J. Humidifier shall include motor, impeller, disk and breaker comb to produce a fine vapor.

K. Rotating parts shall be electronically balanced to eliminate vibration.

2.13 Air Purifire.

A. Air Purifire shall have Powerful air purification to increase indoor air quality, using Streamer technology

B. Air Purifire shall have a quiet operation.

C. Air Purifire shall have Easy to clean flat panel.

2.14 INSTALLATION

A. Install fans level and plumb and according to manufacturer's recommendation

B. Support suspended units from structure using threaded steel rods andspring hangers with vertical-limit stops having a static deflection of 1 inch (25 mm).

C. Install units with clearances for service and maintenance.

D. Label fans according to requirements specified in Division 15 Section "Mechanical Identification."

2.15 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and

duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

2.16 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Adjust belt tension.
   5. Adjust damper linkages for proper damper operation.
   6. Verify lubrication for bearings and other moving parts.
   7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   8. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

2.17 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

2.18 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

2.19 DEMONSTRATION

A. Engage a factory – authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain fans and controllers.

2.20 Air Curtains

Electric air curtains, operating at two different speeds (TWO OPERATING SPEED), so that they are of a length not less than the width of the doors, and the outer surface of them is aluminum and not painted iron, and the price includes the electrical installation, and that it is from a well-known.

END OF SECTION 15837

LIST OF RECOMMENDED MANUFACTURERS

MECHANICAL WORKS

Item No	Description	Alternative (1)		Alternative (2)		Alternative (3)	
		Manufacturer	Origin	Manufacturer	Origin	Manufacturer	Origin
1.	Air Conditioning System (AC-SPLIT SYSTEM)	MIDEA OR AUX OR TOSSOTT OR HISSENSSE	(CHINA)	PETRA OR NATIONAL DELUX	(LOCAL)	TRANE OR CARRIER OR YORK	(CHINA OR USA)
2.	FANS	CASSALS	(SPAIN)	VORTICE	(Italy)	S&P	(Spain)
3.	PUMPS	EBARA	(ITALY)	LOWARA	(ITALY)	DAB	(Italy)
4.	SANITARY FIXTURES	DURAVIT	(UK)	IDEAL STANDARD	(GERMANY)	ROCA	SPAIN
5.	MIXERS	GHROHI	(GERMANY)	ROCA	(SPAIN)	IDEAL STANDARD	(GERMANY)
6.	PRESSURE VISSELS	ARMSTRONG	(UK)	REFLEX	(GERMANY)	Approval Equal	USA
7.	VALVES & PRV	CRANE	(UK)	OVEN TROP	(GERMANY)	HATERSLY	(UK)
8.	VOLUME DAMPERS	BETEC	(USA)	BETA	(USA)	APPROVAL EQUAL	(ARABIAN GULF)

LIST OF RECOMMENDED MANUFACTURERS

MECHANICAL WORKS

Item No	Description	Alternative(1)		Alternative(2)		Alternative (3)	
		Manufacturer	Origin	Manufacturer	Origin	Manufacturer	Origin
9.	GI SHEETS	SABIC	(KSA)	KHOLOSI	LOCAL	Al-SHAREQA	UAE
10.	INSULATION	KIMMCO	(KWIAIT)	IZOCAM	(TURKY)	AFG	(KSA)
11.	AIR OUTLETS, GRILLS AND DIFFUSERS	NATIONAL FACTORY	(KSA)	COOLING INDUSTRIES	(LOCAL)	JORDAN HOUSE	(LOCAL)
12.	PEX PIPES AND FITTINGS	Alam Plastic	(LOCAL)	Al-tayseer	(LOCAL)	Engineering Plastic	LOCAL
13.	BLACK STEEL PIPES	Ukrainian Approval Equal		China Approval Equal			
14.	GALVANISED STEEL PIPES	Al-Arabiyeh	(LOCAL)	Local Approval Equal	LOCAL		
15.	COPPER PIPES AND FITTINGS	MULLER	(UK)	LOWTON TUBES	(USA)		
16.	ROOF, FLOOR DRAINS AND CLEAN OUT	Addasani	(Kuwait)	FABBCO	(KSA)	EUROPE OR ARABIAN GULF (APPROVAL EQUAL)	
17.	BLAK STEEL, GALVANIZED FITTINGS	CRANE	(UK)	AFL	(UK)	GF	ITALY
18.	COLLETORS	GIACOMINI	(ITALLY)	APPE	(ITALY)	TIAMMI	ITALY
19.	WATER CABINETS	LOCAL STANLESS STEEL 316	(LOCAL)				

LIST OF RECOMMENDED MANUFACTURERS

MECHANICAL WORKS

20.	UPVC	ALZGHYER & MARRAR	(LOCAL)	ENGINEERING PLASTIC	LOCAL	ALAM PLASTIC	LOCAL
21.	PPR & PPR-CT	AL-TAYSEER	LOCAL	ALAM PLASTIC	LOCAL	API	LEBANON
22.	HDPE	ALAM PLASTIC	LOCAL	ALZGHYER & MARRAR	LOCAL	ANY APPROVAL EQUAL	LOCAL
23.	PP SILENT PIPE	WAVIN	GERMANY	VALSEER	ITALY	HAMZA	EGYPT
24.	OIL SEPERATORE	KESSELL	GERMANY	UK APPROVAL EQUAL	UK		
25.	POLYETHELEN WATER TANKS	ZAMIL	KSA	USA APPROVAL EQUAL	USA	KOREAN APPROVAL EQUAL	KOREAN
26.	CAST IRON ROOF DRAIN FOR HANGERS	MIFAB	USA	EUROPE APPROVAL EQUAL	EUROPE		