Foreword

According to the requirements of Document JIANBIAO [2009] No.88 issued by the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD) – "Notice on Printing and Distributing 'the Development and Revision Plan of National Engineering Construction Standards in 2009'", this code is completed by Electronic Engineering Standards Quota Station of Electronic Industry Standardization Institute of Ministry of Industry and Information Technology of the People's Republic of China, China Electronics Engineering Design Institute together with relevant units.

In the compilation process, the compiling group investigated and visited the domestic production companies, design companies and construction companies in liquid crystal display field, collected the design requirements of liquid crystal display factories, carefully summarized the practical experience, referred to relevant international standards and foreign advanced standards, and on the basis of extensively soliciting opinions, it is revised repeatedly and finalized after examination.

This code consists of 14 chapters and 2 appendixes, covering: general provisions, terms, basic requirements, process design, site selection and master plan, architectural design, structural design, gases & utilities, heating, ventilation, air conditioning and cleaning, water supply and drainage, electrical design, anti-static, chemicals supply, space management etc.

The provisions printed in bold type are mandatory ones and must be implemented strictly.

This code is under the jurisdiction of, and its mandatory provisions are interpreted by the Ministry of Housing and Urban-Rural Development of the People's Republic of China. The Ministry of Industry and Information Technology is responsible for its routine management, and China Electronics Engineering Design Institute is in charge of the explanation of technical specifications. All relevant organizations are kindly invited to summarize and accumulate actual experiences when implementing this code. If any modification and supplement is required, Relevant comments and recommendations, whenever necessary, should be submitted to China Electronics Engineering Design Institute (Address: No. 160 West Fourth Ring North Road, Haidian District, Beijing, Postcode: 100142, Fax: 010-88193999) for reference of future revision.

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Contents

1 General provisions

1.0.1 This code is prepared with a view to implement the relevant national laws and regulations in the design of the thin film transistor liquid crystal display (TFT-LCD) plant, to meet the production requirements of the thin film transistor liquid crystal display, to ensure the safety of personal and property, to achieve safety and reliability, energy saving and environmental protection, advanced technology, cost-effectiveness and quality assurance.

1.0.2 This code is applicable to the engineering design of new construction, renovation and extension of thin film transistor liquid crystal display plants.

1.0.3 In addition to the requirements in this code, the design of the thin film transistor liquid crystal display (TFT-LCD) plant shall also meet the requirements of the current relevant standards of the nation.

2 Terms

2.0.1 Thin film transistor liquid crystal display(TFT-LCD)

Liquid crystal display with pixel driven directly by active matrix and using thin-film transistors as control pixel switches.

2.0.2 Automated material handling system(AMHS)

The system that a series of related automation tools and device coordinately and reasonably moving, storing and controlling material in a process or logical action system.

2.0.3 Glass substrate

The basic part of liquid crystal display that composed of thin glass sheet with an extremely flat surface.

2.0.4 Array

The process to fabricate regular array of specific thin film transistors (switching devices) to form data lines, storage capacitors and signal lines by coating, photolithography etching and other semiconductor process technologies on a glass substrate.

2.0.5 Color filter(CF)

The filters with three primary colors of red, green and blue arranged regularly on a transparent substrate to pass only the required color light, also known as color filters.

2.0.6 Cell

The liquid crystal cell(screen) process of assembling the prepared Array glass substrate and CF glass substrate of the thin film transistor liquid crystal display together, filling liquid crystal into the space between two glass substrates, and adding an adapted electric field to display images.

2.0.7 Space management

The design of the coordination between various disciplines for as large as the building layout of the entire plant site, underground piping or as small as an individual building in order to effectively use the space and shorten the work process.

2.0.8 Dry etching process

The method of etching substrate surface and etched substance in gas phase.

2.0.9 Plasma enhanced chemical vapor deposition(PECVD)

The reaction of carrying out chemical vapor deposition at lower temperature by utilizing the activity promoting reaction of plasma.

3 Basic requirements

3.0.1 The design of the TFT-LCD plant shall use resources reasonably, protect the environment, prevent and reduce the pollution and harm of waste gas, waste water, waste chemical, waste residue, dust, noise, vibration and electromagnetic radiation generated in the production and construction activities to the environment.

3.0.2 The design of the TFT-LCD plant shall be in accordance with the following requirements:

1 According to the characteristics of the production process, new technologies, new equipment and new materials for energy conservation and environmental protection shall be adopted.

2 Shall meet the requirements of tools installation, commissioning and overhaul, safety production, and maintenance management.

3 Measures shall be taken to meet the requirements of fire safety.

4 Energy saving measures shall be taken.

5 Shall meet the requirement of huge space and clean environment for the production of TFT-LCD.

3.0.3 The design capability of the TFT-LCD production line shall be in accordance with the requirements of economic scale, and the design shall reserve conditions for future production development or process improvement according to the enterprise development plan.

4 Process design

4.1 General requirements

4.1.1 The process design shall be in accordance with the following requirements:

1 Shall ensure production efficiency and product quality.

2 Shall prevent and reduce the damage and harm to workers' health caused by occupational disease hazards, and reduce the labor intensity of workers.

3 Shall be flexible and adaptable.

4 Shall be beneficial to reduce engineering construction cost and running cost.

4.1.2 The production space and layout, production environment parameters and utility supply determined in the process design shall meet the requirements of process, and the necessary conditions shall be reserved for the upgrade and transformation of production technology.

4.1.3 The production department directly related to the production process should adopt a continuously running production organization method, and the work shifts of other auxiliary production departments may be determined according to production needs.

4.2 Basic process

4.2.1 The production process may be determined according to the contents of procedures of the various process listed in Appendix A of this code.

4.2.2 The main production process shall be complete and match, Array, CF and Cell process should be set in the same plant.

4.2.3 The auxiliary production and technical service facilities related to the main production process shall be set up in the plant.

4.3 Process layout

4.3.1 The process layout of the key production area of Array, CF and Cell shall be in accordance with the following requirements:

1 The combination of process layout shall be according to the process characteristics and environmental requirements, and the multiple-storey arrangement should be adopted.

2 The process layout shall prevent the effects of vibration, electromagnetic radiation, heat radiation and air pollution between process tools.

3 The entrances of people and logistics into the production area shall be set up separately, and the corresponding clean facilities for personal and material shall be set up.

4 The production area shall be equipped with equipment move in entrances and passage; Equipment lifting and loading platforms shall be installed when the installation height of the equipment in the production area is 1.5m higher than outside floor.

5 The process tools in each process section shall be arranged according to the process flow and the principle of process concentration.

6 The production auxiliary department closely linked to production shall be located close to the

production area.

4.3.2 When visiting facilities are set up in the production area, the environment of the visiting area and its passages shall be isolated from the production environment, and the flow of logistics and personnel evacuation passages in the production area shall be kept clear.

4.3.3 The plant shall be equipped with storage facilities for raw and auxiliary materials and waste, and the warehouse shall be in accordance with the following requirements:

1 According to the physical and chemical characteristics of the stored materials and storage environment requirements, various warehouses shall be set up by category. The physical and chemical characteristics of the chemicals shall be subject to the chemical Material Safety Data Sheets (MSDS) provided by the relevant chemical suppliers, and the design of the chemical storage area shall meet the requirements of the relevant provisions of Articles 13.2.1–13.2.6 in this code.

2 The warehouses of raw and auxiliary materials and product shall be equipped with loading and unloading platforms.

4.3.4 When there is an air plenum in the key production area, equipment handling and maintenance passage shall be provided in the plenum.

4.4 Equipment configuration

4.4.1 The selection of production tools and auxiliary tools shall meet the requirements of the current national standard GB 50472 *Code for Design of Electronic Industry Clean Room*, and tools with high automation, low energy consumption and low emissions should be used.

4.4.2 Glass substrate cassettes or other special transportation products shall be used in Array, CF and Cell process, and Automatic Material Handling System (AMHS) should be used in the batch production line. When the production area is multi-storey, automatic vertical transportation equipment should be set up for product handling between the cross-storey production areas.

4.4.3 The area of chemical vapor deposition and physical vapor deposition shall be equipped with dedicated cleanroom type maintenance lifting equipment.

5 Site selection and master plan

5.1 Site selection

5.1.1 The site selection shall be in accordance with the requirements of industrial layout and regional construction planning. The construction site shall be selected with comparison in respects of construction scale, raw material source, transportation, power source, water source, gas source, geotechnical conditions, inter-corporation links, site conditions, environments, market flow etc.

5.1.2 The site selection shall be in accordance with the following requirements:

1 Shall avoid production hazards or harmful factors affecting the surrounding people living or activity environment.

2 Shall avoid areas with high atmospheric dust content and areas containing chemical substances that affect process production.

3 The vibration source and vibration value of the construction site shall not affect the process production.

5.1.3 The construction site shall have water source, power supply and gas which are necessary for production, living and future development, and the power and water supply lines shall be short and reliable.

5.1.4 The site selection shall meet the needs of the enterprise's long-term development planning.

5.1.5 Construction site shall not be selected in areas with complicated geotechnical and hydrological conditions, or seismic fortification intensity higher than 8 degrees, or valuable mining areas.

5.1.6 The TFT-LCD plant shall be designed as class Ⅰ flood control standard in the current national standard GB 50201 *Standard for Flood Control*, and the site design elevation shall be 0.5m above the designed frequency water level.

5.2 Site master plan

5.2.1 The general planning of the plant shall be in accordance with the planning requirements by local authorities having jurisdiction, and shall be benefit to the cooperation with neighboring industrial enterprises in transportation, utility facilities, comprehensive utilization and living facilities.

5.2.2 The master plan of the plant shall be in accordance with the following requirements:

1 The master plan shall be in accordance with the production process flow and micro-vibration control requirements. According to the production process characteristics and the specific requirements of various functional areas, the fabrication building should be combined and to be multi-storey.

2 The production area, utility auxiliary area, storage area, office and living area shall be arranged reasonably. All support and auxiliary facilities should be close to the workshops they served, and utility supply facilities should be close to the load center.

3 The shape of the building should be regular, and administrative offices and living facilities should be centralized.

4 The transportation routes of raw materials shall be short and convenient, and cross-interference between logistics and people flow shall be avoided.

5.2.3 Modification or expansion of existing TFT-LCD plant shall be master planned making reasonable use of the existing facilities and reducing the impacts to existing production operation.

5.2.4 For factory buildings with micro-vibration control requirements, existing and simulated vibration sources shall be actually measured for comparison to tolerable value before site decision.

5.2.5 The warehouses, tanks, and storage yards storing flammable, explosive and toxic materials should be arranged at the windward side of the annual minimum frequency of the site. And shall be away from fire sources, main buildings(structures), and crowded area. Fire dike, protection walls or curbs to prevent accidental leakage shall be provided around liquid tanks complying with the current national standard GB 50016 *Code for Fire Protection Design of Buildings*. Dedicated fences and entrance should be provided for storage area.

5.2.6 The distance between warehouses, tanks, yards and buildings, roads shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*.

5.2.7 Site elevation design should make full use of the original terrain to reduce earthwork. When using step site elevation, buildings or structures with close production links shall be arranged on the same or adjacent steps.

5.2.8 The exterior pipelines of water supply, drainage, circulating water and cables should be laid underground. And the pipelines of flammable and combustible liquids, gas, hot water, steam, compressed air, bulk gas, special gas etc. should be on pipe racks above-ground. All pipelines layout shall meet the requirements of current national standard GB 50187 *Code for Design of General Layout of Industrial Enterprises*.

6 Architectural design

6.1 General requirements

6.1.1 The architectural plan and space of the factory buildings shall be adapted to the flexibility of production development and shall meet the requirements of production process transformation and production scale expansion.

6.1.2 Overhead bridges should be provided for people and logistic flow between fabrication building, office buildings, utility buildings in thin film transistor liquid crystal display plant.

6.1.3 Expansion joints in clean production zone of factory buildings should not be installed.

6.1.4 Fabrication building enclosure materials shall meet production environment requirements in respect of airtightness, thermal insulation, fire prevention, moisture resistance, dust prevention, durability, and easy cleaning.

6.1.5 The limitation of the heat transfer coefficient of the factory building enclosure shall meet the requirements of the current national standard GB 50710 *Code for Design of Energy Conservation of Electronic Industry*. The inner surface temperature of the exterior walls, exterior windows and roof shall not be lower than the indoor air dew point temperature.

6.1.6 Entrance and platform for process tools and utility equipment move in shall be provided in factory buildings.

6.1.7 Passages shall be considered for process tools and utility equipment move in and installation in the factory building. Width of the passage shall allow personnel operation, material transportation, equipment installation and maintenance.

6.1.8 The raised floor located in move-in passage shall be strong enough to withstand move-in load.

6.1.9 The interior decoration of the factory building shall meet the requirements of the current national standards GB 50222 *Code for Fire Protection in Design of Interior Decoration of Buildings* and GB 50472 *Code for Design of Electronic Industry Clean Room*.

6.2 Fire protection

6.2.1 The fire resistance class of the factory building of TFT-LCD shall not be lower than class Ⅱ.

6.2.2 The classification of fire hazards of each workshop in factory building shall meet the requirements of the current national standards GB 50016 *Code for Fire Protection Design of Buildings* and GB 50472 *Code for Design of Electronic Industry Clean Room*.

6.2.3 The division of fire compartments in factory building shall meet the requirements of the current national standards GB 50016 *Code for Fire Protection Design of Buildings* and GB 50472 *Code for Design of Electronic Industry Clean Room*. In cleanroom of Array, Cell, CF, Module, maximum area of each fire compartment may be allowed as production demand, provided that fire alarm and extinguishing devices are equipped in key process tools, and early smoke detection system with sensitivity greater than 0.01% obs/m is installed in return air flow.

6.2.4 The safety exits of factory building shall be in accordance with following requirements:

1 The quantity of safety exits shall meet the requirements of the current national standards GB

50016 *Code for Fire Protection Design of Buildings* and GB 50472 *Code for Design of Electronic Industry Clean Room*.

2 The distance from any point in factory building to the nearest safe exit shall meet the requirements of the current national standards GB 50016 *Code for Fire Protection Design of Buildings* and GB 50472 *Code for Design of Electronic Industry Clean Room*.

3 In cleanroom of Array, Cell, CF, and Module building, the safety evacuation distance shall be no larger than multiply 1.5 of distance specified in Item 2 above, provided that fire alarm and extinguishing devices are equipped in key process tools, and early smoke detection system with sensitivity greater than 0.01%obs/m is installed in return air flow. and when cleanroom worker density is less than 0.02 person / m^2, safety evacuation distance shall be no larger than 120m.

4 In Array, Cell, CF, and Module building, when cleanroom worker density is less than 0.02 person/m^2, and the cleanroom and technical support area are located in different fire compartments, the safety exit may be shared. Safety exits shall be provided with shared vestibule or safe passage.

6.2.5 Doors or windows on exterior wall for firefighter access into factory building shall be designed for cleanroom against exterior wall on each floor, Additional dedicated fire-fighting accesses are required where the distance between the openings is larger than 80m. The design of the fire-fighting access shall meet the requirements of the current national standard GB 50073 *Code for Design of Clean Room*.

6.2.6 Except for the material entrance, the automatic vertical handling system passing through different fabrication floors shall be enclosed with non-combustible material of fire rate no less than 0.4h. The fire protection measure for material entrance shall be comply with Article10.6.6 of this code.

6.2.7 The distribution room for flammable and explosive chemicals and gases shall be arranged against the exterior wall, and the pressure relief area of the room shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*. Location right above, below or adjacent to crowded room or evacuation passage is prohibited.

6.2.8 Non-sparking anti-static floor finish shall be used in storage and distribution rooms for combustible and explosive chemicals. Corrosion-resistant floor finish shall be used in storage and distribution rooms for corrosive chemicals.

7 Structural design

7.1 General requirements

7.1.1 The seismic fortification of Array, CF and Cell building should be categorized as important protection.

7.1.2 The distance between adjacent beams of production floor of Array, CF and Cell building or the distance between adjacent openings on the beamless thick floor slab should be multiple of 600mm.

7.1.3 The structural design of Array, CF and Cell building shall meet the micro-vibration control standards of the process tools.

7.1.4 Rubber isolator shall not be installed between upper structure and building foundation.

7.2 Structural design

7.2.1 Reinforced concrete structure or steel-concrete mixed structure should be adopted for the factory building.

7.2.2 Structural expansion joint should be installed between key area and support area, office area of fabrication building.

7.2.3 Expansion joint should not be installed between the floor structure of key area and the main structure supporting the roof.

7.2.4 Depending on column grid and bay spacing, the roof system of the factory building may be:

1 Cast-in-place reinforced concrete roof.

2 Cast-in-place reinforced concrete roof with steel beam and steel deck plate.

3 Cast-in-place reinforced concrete roof with steel truss, steel beam and steel deck plate.

4 Light roof of steel deck plate with heat insulation.

7.2.5 In case expansion joints shall not be installed in key production zone of fabrication building, measures shall be taken to reduce the impact of temperature changes and concrete shrinkage on the structure.

7.2.6 Inter-column bracing should be set for frame structure when the multi-storey fabrication building using for production process.

7.2.7 The standard value of the floor load shall be determined according to equipment layout, weight and the detail of anti-vibration pads.

7.2.8 The hanging load of the floor and roof shall be determined according to detail of hanging structure, layout of pipes and equipment, etc.

7.2.9 In the overall structure seismic calculation of the factory building, the representative value of gravity load of the building should be determined according to the actual equipment load on the floor.

7.2.10 Calculation of factory building structure shall base on actual process tools layout, transportation route. And load capacity of beams, columns, foundations shall be verified in case of normal status and ultimate load status.

7.2.11 In overall structural calculation of the fabrication building, the actual bending stiffness of the floor frame beam shall be used for structural analysis.

7.2.12 Pre-stressed structure should not be adopted for reinforced concrete beams in key production zone of fabrication building.

7.2.13 Chambered beams and columns should be adopted for concrete structure in key production zone.

7.2.14 The flatness of the top of the reinforced concrete beam or steel beam of the production floor shall meet the requirements of no larger than 2mm within 2m and no larger than 25mm within 50m.

7.2.15 Steel structure should be adopted for visiting passage in factory building.

7.2.16 The foundation of the equipment shall not cross the expansion joint.

7.3 Vibration control standard

7.3.1 For process tools with micro-vibration control requirements, the manufacturer shall provide the vibration evaluation method, micro-vibration control standards and requirements at the tools pedestal.

7.3.2 The vibration value of the support surface of the process tools with micro vibration control requirements shall be below the corresponding micro vibration standard curve. Micro-vibration standard curve may be adopted according to Appendix B of this code.

7.3.3 For process tools such as Exposure, Coater, the dynamic stiffness standard value of the tools support part shall meet the manufacturer's requirements.

7.4 Vibration control design and test

7.4.1 Micro vibration control design shall include the following factors:

1 Vibration source outside the factory building.

2 Vibration caused by employees walking in the plant.

3 Vibration caused by process tools and utility equipment operation.

4 Vibration caused by flow in pipes.

5 Natural frequency of process tools.

7.4.2 In the same production floor, different micro-vibration control standards may be selected in the vertical direction according to the micro-vibration control requirements of different tools, and the micro-vibration control standard in the horizontal direction shall be selected according to the strictest one in all tools.

7.4.3 Small column grid shall be used for production floor. Column grid should not be larger than 6m for VC-C standard, and should not be larger than 10m for VC-A/B standard.

7.4.4 The ground floor slab shall be reinforced concrete structure, the thickness of which should not less than 400mm, and shall be integrated with the main structure.

7.4.5 Micro vibration control shall be tested and analyzed in following steps:

1 Investigation, vibration test, analysis and evaluation of site environmental vibration sources.

2 Testing and analysis of dynamic characteristics of structural floors.

3 Vibration test, analysis and evaluation of equipment foundation in operation.

4 Vibration test, analysis and evaluation of tools pad in operation.

7.5 Pedestal design

7.5.1 The appropriate structure of vibration pad shall be selected according to the micro-vibration control standards of the process floor and the technical requirements of the tool.

7.5.2 The thickness of the reinforced concrete of vibration pad should not be less than 200mm.

7.5.3 The gap between vibration pad and access floor should not be larger than 10mm.

7.5.4 The natural frequency of vibration pad shall avoid the natural frequency of its supporting structure.

8 Gases & utilities

8.1 Cooling and heating source

8.1.1 The artificial cold and heat sources of the plant should adopt centralized chilled(hot)water units and heat supply and heat exchange equipment. Equipment type and size shall be selected according to local climate, energy structure, policies, prices and environmental regulations. And shall be in accordance with following requirements:

1 Residual heat or urban heat is in first priority.

2 In areas with urban industrial natural gas supply, gas boilers, gas water heaters may be used for heat supply, or gas absorption chilled(hot)water units may be used for cool and heat supply.

3 Otherwise, fuel boilers for heating, electrical chillers for cooling and fuel absorption chilled(hot) water units for cooling and heating may be used.

4 Air-source heat pump or ground-source heat pump may be used for office building etc. in hot-summer/cold-winter, droughty region.

5 Water-source heat pump may be used where natural water source is rich.

8.1.2 Under working conditions that require both cooling and heating, the heat recovery type chiller unit should be selected according to the load requirements. And automatic adjusting heat supply should be used.

8.1.3 Equipment quantity and capacity shall be decided by annual cooling and heating load conditions, and should assure equipment to be operated safely and efficiently under full and partial load conditions.

8.1.4 Cooling towers should be adopted whenever cooling load is needed in transition season or winter.

8.1.5 Chilled water supply and return temperature difference should be 7℃. Supply and return temperature difference and chiller outlet temperature shall be higher as possible, provided the chilled water temperature is meeting production and air conditioning need.

8.1.6 Variable frequency drive(VFD)should be adopted for all or partial chilled water system equipment if cooling load varies greatly.

8.1.7 The coefficient of performance(COP)of chiller shall not be less than standard specified in GB 19577 *The Minimum Allowable Values of the Energy Efficiency and Energy Efficiency Grades for Water Chillers*, and equipment with higher COP shall be in first priority.

8.1.8 Electric compression chillers shall meet the requirements of the current national standard GB 50019 *Design Code for Heating Ventilation and Air Conditioning of Industrial Buildings*.

8.1.9 Fuel or gas boilers shall be fully automatic with proportion adjusting burners, and dedicated stack should be adopted for each boiler. The height of the stack shall meet the requirements of the current national standard GB 13271 *Emission Standard of Air Pollutants for Boiler* and the project environmental assessment report.

8.1.10 The air pollutants discharged from the boiler room shall meet the requirements of the current national standard GB 16297 *Integrated Emission Standards of Air Pollutants* and local regulations on the air pollutants emission.

8.2 Bulk gases supply

8.2.1 The design of bulk gas supply system shall be in accordance with the following requirements:

1 The type of bulk gas shall be determined by production needs, and the gas quality shall meet the production process requirements.

2 The way of bulk gas supply shall be determined according to various factors such as gas consumption, gas quality and local gas supply status.

3 Discharge pipe is required at terminal and the highest point in oxygen and hydrogen pipeline. Discharge pipe shall be led to outdoor and discharge exit shall be at least 1m higher than the building ridge. Flame arrester is required in hydrogen discharge pipe.

4 Gas main pipe in cleanroom shall be installed in air plenum or shaft.

5 Hydrogen pipeline in cleanroom shall be surface mounted. And sleeve is required at penetration of wall or floor slab. No welding seam is allowed in sleeve. The gap between pipeline and sleeve shall be sealed.

6 Hydrogen pipelines shall not pass through any rooms not served. If must, pipe sleeve or double contained pipe shall be used.

7 Hydrogen and oxygen pipelines shall be grounded for electrostatic discharge.

8.2.2 The process design of the high-purity bulk gas supply system shall meet the requirements of the current national standard GB 50724 *Technical Code for Bulk Gas Purification and Delivery System Engineering*.

8.2.3 Bulk gas purification room or gas entry room with hydrogen devices shall be defined as fire hazardous class A, and shall be in accordance with following requirements:

1 Combustible gas devices shall be installed against the outer wall, and explosion-proof and pressure relief facilities shall be provided.

2 Automatic shut-off valve shall be installed on the pipeline of combustible gas such as hydrogen.

3 Well ventilated and emergency exhaust is required.

4 Leakage detection device is required, and shall be interlocked with emergency exhaust system.

8.2.4 Bulk gas pipelines and valves shall be selected according to production process requirements, and shall be in accordance with the following requirements:

1 For gas purified larger than or equal to 99.999 9%, electro-polished austenitic ultra-low carbon stainless-steel seamless pipe should be used. Diaphragm valve or bellow valve shall be used.

2 For gas purified larger than or equal to 99.999% and the dew point is less than −76℃, electro-polished austenitic ultra-low carbon or low carbon stainless-steel seamless pipe should be used. Diaphragm valve or bellows valve should be used.

3 For gas purified larger than or equal to 99.99% and the dew point is less than −60℃, electro-polished austenitic stainless steel seamless pipes should be used. Bellow valve should be used for combustible gas pipe, and ball valve for other gas pipes.

4 Material of valves and accessories should be same as the pipelines connected.

8.2.5 Bulk gas pipeline connection shall be in accordance with the following requirements:

1 The stainless-steel pipe shall be argon arc welded, automatic argon arc welding or plasma fusion butt welding should be used.

2 For the connection between pipelines and equipment or valves, surface-sealed joints or double

ferrules should be used. The joint or double ferrules should be sealed with metal or Teflon washer.

3 The connection between the pipeline and the equipment shall be in accordance with the equipment manufacture's requirements. When using hose connection, metal hose shall be used.

8.3 Special gases supply

8.3.1 Out-sourced cylinder shall be used for the supply of special gas. Special gas storage and distribution system shall be set up in the plant.

8.3.2 Special gas supply, storage and distribution system equipment shall be arranged in an independent structure or a dedicated room in fabrication building depending on nature and storage quantity of special gas.

8.3.3 The fire hazard determination of special gas equipment arranged in an independent building (structure) or area shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*.

8.3.4 The fire hazard of the distribution rooms for spontaneous or combustible special gas equipment in fabrication building shall be classified as A.

8.3.5 For new-built project, silicane system shall be installed in a separate building. For modification or expansion project, silicane system may be installed in other gas station, and shall be separated with other gas rooms by explosion-proof wall.

8.3.6 The installation of gas cylinder cabinets and cylinder racks for special gas systems shall meet the requirements of the current national standard GB 50646 *Technical Code for Specialty Gas System Engineering*.

8.3.7 Combustible gas cylinder cabinets shall be in accordance with following requirements:

1 Air change rate no less than 1 200/h, negative pressure of the cylinder cabinet continuously monitored.

2 Ultraviolet or infrared flame detector and automatic fire extinguishing system required for spontaneous gas cabinet.

3 Automatic fire extinguishing system required for combustible gas cabinet.

4 Steel panel separation for each cylinder required in spontaneous or combustible special gas cabinet.

8.3.8 Purging nitrogen for special gas system shall be in accordance with following requirements:

1 Purging nitrogen for special gas system shall be connected to an independent nitrogen source, isolated from common or process nitrogen system.

2 Purging nitrogen of incompatible special gas system shall not share the same nitrogen source.

3 Check valve shall be provided in purging nitrogen pipeline.

8.3.9 Special gas exhaust and waste treatment shall be in accordance with the following requirements:

1 Nitrogen dilution and continuous purging are required in exhaust pipe of special gas system, preventing pollution and corrosion caused by backflow of air.

2 The exhaust of incompatible special gas shall not be connected to the same exhaust main pipe.

3 The exhaust of spontaneous combustion, flammable, toxic, corrosive special gases shall be treated emission standards.

8.3.10 Flammable and toxic special gas pipelines in fabrication building shall be surface mounted, sleeves required at wall or slab penetration, no wielding seam allowed in sleeve. The gap between

pipeline and sleeve shall be sealed. Mechanical connection of flammable, toxic and corrosive gas pipeline shall be placed in exhaust hood.

8.3.11 Pipes and fittings for special gas and purge gas shall be made of austenitic ultra-low carbon seamless stainless-steel pipe, and the inner surface shall be cleaned and passivated.

8.3.12 Combustible and oxidizing special gas pipelines shall be provided with grounding facilities for electrostatic discharge.

8.3.13 Outdoor special gas pipelines shall be installed overhead.

8.3.14 Double containment should be used for spontaneous combustible, highly toxic and strong corrosive special gas. The space between double containment may be closed or open.

8.4 Compressed air supply

8.4.1 The compressed dry air (CDA) system shall meet t production process requirements regarding supply volume and quality, and shall be in accordance with following requirements:

1 Compressed dry air system shall be sized based on production demand and system loss.

2 Compressed dry air system may be installed in gas station in fabrication building or independent utility building.

3 Compressed dry air supply equipment shall be energy saving and low noise. Non-lubricated air compressor shall be used.

8.4.2 Air-cooling air compressor and dryer shall be well arranged to prevent short circuit of cooling air.

8.4.3 Electro-polished stainless-steel pipe shall be used for compressed dry air with dew point lower than −76℃; Stainless steel or hot-dip galvanized seamless steel pipe shall be used for compressed dry air with dew point lower than −40℃.

8.4.4 Compressed dry air pipes shall be in accordance with following requirements:

1 Ring or branch layout should be used for compressed dry air main pipe.

2 Compressed dry air main pipe shall be sized to meet actual consumption of the whole system. Sub-main pipe shall be sized to meet actual consumption it served. Branch pipe shall be sized to meet max consumption of the equipment.

3 Metal gasket or PTFE gasket should be used for compressed dry air pipe with dew point lower than −40℃.

4 When using hose connection, metal hose should be used.

8.5 Process and cleaning vacuum

8.5.1 The design of the process vacuum system shall be in accordance with following requirements:

1 Process vacuum capacity shall be sized to meet production process demand and the system loss.

2 Vacuum equipment shall be installed in fabrication building.

3 Low energy consumption and low noise equipment shall be used for process vacuum.

4 Water ring or dry vacuum pump shall be selected according to process demand.

5 Low vacuum pressure protection devices should be used for process vacuum system.

8.5.2 The design of process vacuum piping shall be in accordance with following requirements:

1 Process vacuum piping should be arranged in branch system.

2 Vacuum main pipe shall be sized to meet actual consumption of the whole system. Sub-main pipe shall be sized to meet actual consumption it served. Branch pipe shall be sized to meet max

consumption of the equipment.

3 Stainless steel or thick-wall polyvinyl chloride(PVC)pipe should be used for vacuum system as for pressure and characteristics of the process vacuum system.

4 Metal hose shall be used if needed.

8.5.3 Centralized house vacuum system should be provided in cleanroom(zone). Vacuum pipe in cleanroom should be embedded.

9 Heating, ventilation, air conditioning and cleaning

9.1 General requirements

9.1.1 Classification and type of cleanroom(zone)shall be defined according to production environment requirements provided by production process.

9.1.2 Cleanroom (zone) airflow shall be determined according to the classification and production process requirements.

9.1.3 Besides to meet the requirements of the current national standard GB 50472 *Code for Design of Electronic Industry Clean Room*, the principle of separating the cleaning and air conditioning system shall be in accordance with following requirements:

1 Cleanrooms with large differences in temperature and humidity shall be provided with separated purification and air conditioning systems.

2 Cleanrooms with large different of allowable fluctuation range in temperature and humidity shall be provided with separated purification and air conditioning systems.

9.1.4 The fresh air volume for cleanroom shall be the bigger one of the following:

1 The sum of the amount of fresh air required to compensate for the exhaust air volume and maintain the indoor positive pressure.

2 Fresh air volume to assure no less than $40m^3$ per person per hour working in cleanroom.

9.1.5 A certain static pressure difference shall be maintained between cleanroom and the surrounding space. The static pressure difference shall be in accordance with the following requirements:

1 The static pressure difference between cleanrooms of different class should be no less than 5Pa.

2 The static pressure difference between cleanroom and non-clean area shall not be less than 5Pa.

3 The static pressure difference between cleanroom and outdoor shall not be less than 10Pa.

9.1.6 Vibration isolator shall be provided for ducts and water pipes installed in key production area of Array, CF, and Cell building.

9.2 Heating, ventilation and waste gas treatment

9.2.1 Anti-freezing and heating facilities shall be provided in utility building and pipe bridge located in severe cold and code region. The heating design of other rooms shall meet the requirements of the current national standard GB 50019 *Design Code for Heating Ventilation and Air Conditioning of Industrial Buildings*.

9.2.2 Heating radiators shall not be installed in cleanroom(zone).

9.2.3 Local exhaust shall be provided for tools in cleanroom generating dusts or harmful gases. And the exhaust hood should be closed.

9.2.4 Design of the exhaust system shall be in accordance with the following requirements:

1 Local exhaust treatment shall be provided for plasma enhanced chemical vapor deposition (PECVD)and dry etching tools.

2 Separate exhaust system shall be designed for acid, alkali, toxic and organic exhaust. Backup fans and emergency power shall be provided.

3 General exhaust system for Array, CF, and Cell building shall be equipped with backup fans.

4 Slope and condensate outlet should be used for exhaust from tools generating condensate. Condensate shall be drained to waste water pipe. And infiltration protection shall be provided in the ducts.

5 The duct of the toxic exhaust system shall be made of stainless-steel plate lined with PTFE.

6 Anti-explosive measures shall be taken for toxic and organic exhaust.

7 Acid, alkali, toxic and organic exhaust duct shall not pass-through fire walls or fire partitions. If must, no fuse type fire damper is allowed.

8 Exhaust treatment equipment for acid, alkali, toxic and organic exhaust systems shall be located at the negative pressure end of the exhaust fan.

9 Duct of the toxic exhaust system shall be provided with a transparent observation port at convenient position, and the airflow in the duct shall not be less than 10m/s.

10 Outdoor duct of the local exhaust system shall be provided with anti-condensation insulation as per local weather conditions.

11 Airflow in exhaust ducts located in key production area of Array, CF and Cell building shall not larger than 12m/s.

12 Backflow protection shall be provided for cleanroom exhaust.

9.2.5 The design of the exhaust treatment system shall be in accordance with the following requirements:

1 Two-stage local treatment should be used for PECVD and dry etching tools. The removal rate of silane and silicon dioxide shall not be less than 98%, and the treatment efficiency of other harmful substances shall not be less than 99%.

2 Toxic exhaust treatment system shall be integrated treatment for acid, alkali and dust.

3 Backup treatment equipment should be used for acid, alkali, organic and toxic exhaust treatment system.

4 Acid, alkali, organic and toxic exhaust shall not be treated by fixed bed adsorbent.

5 Acid, alkali and toxic exhaust should be treated by scrubber. The number and thickness of filler layers, circulating volume shall be calculated and determined according to the factors such as the concentration of inlet harmful substances and emission standards. The chemical dosing, make-up water and drainage for the treatment equipment shall be automatic controlled. Day tank should be set close to treatment equipment.

6 Drainage from treatment equipment shall enter the wastewater treatment system.

7 Organic exhaust should be adsorbed and concentrated by zeolite roller, and then incinerated. Two-stage heat recovery should be used before discharging.

8 Organic exhaust from the stripper should be pretreated before entering the zeolite roller.

9 The stages of exhaust treatment equipment shall be determined according to factors such as the type of harmful substances, initial concentration, local emission standards, efficiency of treatment equipment, etc.

10 For two or more exhaust treatment equipment operating in parallel, electric or pneumatic damper shall be installed at the entrance of each equipment.

9.2.6 Treated acid, alkali, organic and toxic exhaust shall be discharged into the atmosphere through stack. The height of the stack shall meet the requirements of the current national standard GB 16297

Integrated Emission Standard of Air Pollutants and the environmental impact assessment report. Discharge velocity at outlet should not be less than 18m/s.

9.2.7 Online sampling sensors should be installed in stack of acid, alkali, toxic and organic exhaust.

9.2.8 General exhaust should be used as the return air for cleanroom.

9.2.9 Air change rate shall be no less than 10/h for shoe changing room exhaust system, and the exhaust vent should be at lower part of the room. Local exhaust should be provided for shoes locker. Air change rate should be no less than 5/h for first gowning room.

9.3 Air conditioning and cleaning

9.3.1 The fresh air of cleanroom air conditioning system shall be temperature, humidity conditioned and purified in unit. Make-up air unit shall be in accordance with following requirements:

1 Variable frequency drive blower.

2 Make-up air treated by preliminary, medium and high efficiency filters.

3 Backup make-up air unit(MAU)shall be provided for Array, CF and Cell building.

4 Direct drive fan shall be used for Array, CF, and Cell building and vibration isolation shall be provided.

5 Fresh air inlet shall be located away from outlet of harmful or combustible exhaust.

6 Warm water spray should be used for humidification.

7 Good air tightness, air leakage rate under working pressure no larger than 1%.

9.3.2 Fan filter unit and dry cooling coil should be used for treatment of circulating air of Array, CF and Cell building. Circulating air handling unit should be used for circulating air of module and backlight fabrication building.

9.3.3 Raised floors with different resistances for return air should be used for cleanroom over 80m wide Array, CF and Cell building.

9.3.4 Dry cooling coil shall be in accordance with the following requirements:

1 Air velocity should not be larger 2.5m/s.

2 Air resistance shall not be larger than 40Pa.

3 Air resistance difference of dry cool coils installed in one cleanroom(zone)shall be not larger than 10%.

4 Chilled water supply temperature should be higher than dew point of cleanroom(zone).

5 Drain system is required for dry cooling coils, water tray is required for elevated installed coils.

9.3.5 Fan filter unit shall be in accordance with the following requirements:

1 Shall be selected according to air cleanliness level and air supply volume.

2 DC speed regulating motor should be used.

3 Noise-reducing measures is required. No dust-producing materials shall be used. Noise-reducing material combustion performance class B.

4 PTFE filter should not be used for cleanroom(zone)of classification 7 to 9.

5 Easy access for filter installation, maintenance and replacement.

9.3.6 Air velocity in each part of cleanroom using MAU+FFU+dry cool coils shall be in accordance with following requirements:

1 Ceiling plenum shall not larger than 4m/s.

2 Sub-fab shall not larger than 3m/s.

3 Air return shaft shall not larger than 4m/s.

9.3.7 MAU chilled water and hot water system shall be in accordance with following requirements:

1 Low temp chilled water and medium temp chilled water shall be used for cooling of air conditioning. Except for low temp chilled water that shall be used in secondary cooling coil of new air treatment unit, medium chilled water should be used for all other coils.

2 Reverse return piping should be used for medium temp chiller water. Bypass pipe should be provided between the end of the supply main pipe and the return main pipe.

3 Medium chilled water pipes installed inside ceiling, sub-fab and air return shaft shall be insulated.

4 The fixed brackets for the cold and hot water pipes arranged in the key production area of the Array, CF, and Cell building shall not be installed on the building structure.

5 Air conditioners shall not be installed in substation, and no water valve or accessories shall be installed in substation.

9.3.8 Cleanroom air supply volume shall meet the requirements of the current national standard GB 50073 *Code for Design of Clean Room*.

9.3.9 Cleanroom noise level(as-built)shall meet the requirements of the current national standard GB 50472 *Code for Design of Electronic Industry Clean Room*. But for cleanroom using fan filter units and dry cooling coils, noise level(as-built)of the unidirectional flow and mixed flow shall not be larger than 70dB(A), non-unidirectional flow not be larger than 65dB(A).

9.4 Smoke venting

9.4.1 Natural smoke exhaust should be used for smoke-proof staircase, vestibule or shared vestibule in cleanroom. If natural smoke exhaust is not available, mechanical smoke exhaust system shall be installed. Mechanical smoke prevention system shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*.

9.4.2 Mechanical smoke exhaust system shall be provided in evacuation corridor where natural smoke exhaust is not available in cleanroom.

9.4.3 Cleanroom mechanical smoke exhaust system shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*. Mechanical smoke exhaust may not be required provided that the cleanroom employees less than 0.02 person/m^2 and evacuation distance no larger than 80m.

9.4.4 Backflow protection shall be provided for cleanroom(zone)smoke exhaust system. And bypass duct for routine inspection.

9.4.5 When the smoke exhaust duct in the cleanroom(zone)is insulated with dust-producing insulation materials, it shall be a finished heat insulation duct with a double-layer metal plate sandwiched with heat insulation materials. Insulation material shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*. Thickness of inner metal panel shall comply with the current national standard GB 50243 *Code of Acceptance for Construction Quality of Ventilation and Air Conditioning Works*.

9.4.6 Smoke exhaust system shall also meet the requirements of the current national standards GB 50016 *Code for Fire Protection Design of Buildings* and GB 50472 *Code for Design of Electronic Industry Clean Room*.

10 Water supply and drainage

10.1 General requirements

10.1.1 The plumbing main pipes of the clean zone of the TFT-LCD factory building should be laid in the air plenum or air shaft.

10.1.2 The plumbing pipes passing through the cleanroom shall meet the requirements of the current national standard GB 50472 *Code for Design of Electronic Industry Clean Room*.

10.1.3 Pipes in and out of the building should not be buried directly in or under the structural slab.

10.2 General water

10.2.1 The water supply system in the factory building shall be determined by the different requirements of process tools on quality, temperature, pressure and volume of water.

10.2.2 In areas where chemical leakage may occur while storing and using chemicals, emergency showers and eye washers shall be installed according to the physical and chemical properties of the chemicals and personal safety requirements.

10.2.3 The selection of the pipes and fittings of the water supply pipeline shall meet the requirements of the current national standard GB 50472 *Code for Design of Electronic Industry Clean Room*.

10.2.4 Waste water and storm water systems shall meet the requirements of the current national standard GB 50472 *Code for Design of Electronic Industry Clean Room*.

10.2.5 The facilities to store emergency drainage shall be provided at the following areas:

1 Rooms for storing, distributing and collecting liquid chemicals.

2 Outdoor unloading area for liquid chemicals.

10.2.6 The effective volume of the emergency drainage storage facility in the outdoor unloading area may be calculated according to the following formula:

$$V = V_1 + V_2 \tag{10.2.6-1}$$

$$V_2 = 10qF \tag{10.2.6-2}$$

$$q = q_a / n \tag{10.2.6-3}$$

Where, V——Effective volume of emergency drainage storage facility(m^3).

V_1——The maximum chemicals stored in the tank lorry(m^3).

V_2——The potential amount of storm water into the storage facility in the event of an emergency (m^3).

q——Rainstorm intensity(mm)according to average daily rainfall.

q_a——Average annual rainfall(mm).

n——Average annual rainfall days.

F——Stormwater catchment area that must enter the emergency wastewater collection system (ha).

10.3 Pure water

10.3.1 In addition to meet the requirements of the current national standards GB 50472 *Code for*

Design of Electronic Industry Clean Room and GB 50685 *Code for Design of Pure Water System of Electronic Industry*, the deionized water (DI water) system should also be in accordance with the following requirements:

1 The DI water system should include pure water preparation system, distribution system and pure water reclaim and treatment system.

2 In addition to meet the requirements of volume, quality, temperature and pressure, the DI water system shall also meet the requirements of flexible operation, safety and reliability, easy operation and management, and low running costs.

3 The additional capacity of the DI water distribution system should be larger than 20% of the designed water consumption.

4 The recovery rate of the DI water system shall be reasonably determined by the actual situation of the project.

10.3.2 Raw water for DI water preparation prefers to use qualified recycled water.

10.4 Cooling water

10.4.1 Open system should be adopted for process cooling water.

10.4.2 The safety of the power source used in the process cooling water system shall be consistent with the power used in process tools protected by the process cooling system.

10.4.3 The piping and fitting of the process cooling water system shall be determined according to the quality, temperature and pressure of the water.

10.5 Waste water treatment

10.5.1 According to the character, pollutant concentration and volume of waste water discharged from process tools, the discharge pipelines should be set up separately. Hazardous wastewater shall be treated and discharged after reaching national or local discharge standards.

10.5.2 The collection and distribution pipeline of waste water that buried underground shall be in accordance with the following requirements:

1 Wastewater collection and distribution pipelines should be laid in pipe trenches.

2 When the waste water collection and distribution pipelines need to be buried directly, double sleeves and leakage monitoring devices shall be installed to prevent waste water leakage.

10.5.3 The process wastewater treatment system shall be equipped with an emergency tank. The total volume of the tank should not be less than the 6 hours' volume of the largest type of wastewater in the plant.

10.5.4 The pipes, valves and fittings of the process wastewater discharge system shall be determined by the character, concentration and temperature of wastewater.

10.5.5 Wastewater treatment facilities and discharges should be equipped with online monitoring instruments.

10.6 Fire water supply and fire-extinguishing facilities

10.6.1 The fire protection design of the factory building shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*.

10.6.2 The design of the factory building hydrant system shall be in accordance with the following requirements:

1 Indoor fire hydrants shall be installed in the fabrication floor and the sub-fab of the cleanroom (zone)that may be passed through and maintained.

2 The water consumption of indoor and outdoor fire hydrants shall meet the requirements of the current national standard GB 50472 *Code for Design of Electronic Industry Clean Room*.

10.6.3 The automatic sprinkler system installed in the factory building shall be in accordance with the following requirements:

1 The installed automatic sprinkler system shall meet the requirements of the current national standard GB 50084 *Code for Design of Sprinkler Systems*.

2 The automatic sprinkler systems shall be provided for clean production area, as well as the ceiling plenum and sub-fab. The sprinkler intensity shall not be less than 8L/(min · m^2) , and the protection area shall not be less than 160m^2.

3 When the special gas stored in the special gas station(room) does not react with water, wet automatic sprinkler system shall be installed. The sprinkler intensity shall not be less than 8L/(min · m^2), and the protection area should not be less than 160m^2.

4 The deluge system shall be provided for outdoor silane station. The protected areas shall include silane cylinders, bulk silane storage tanks and related process gas cabinets. The spray intensity of the deluge system shall not be less than 12L/(min · m^2), and the fire duration shall not be less than 2h.

5 Wet automatic sprinkler systems should be installed in rooms where silane is stored and used. The sprinkler intensity is not lower than the serious danger level Ⅰ, the sprinkler intensity shall not be less than 12L/(min · m^2), the action area shall not be less than 260m^2.

10.6.4 The gas fire extinguishing system installed in the factory building shall meet the requirements of the current national standards GB 50370 *Code for Design of Gas Fire Extinguishing Systems*, GB 50193 *Code of Design for Carbon Dioxide Fire Extinguishing Systems*, and GB 50140 *Code for Design of Extinguisher Distribution in Buildings*.

10.6.5 The fire extinguishers installed in the factory building shall be in accordance with the following requirements:

1 The fire extinguishers in clean zone should be carbon dioxide type.

2 The fire extinguishers setting in areas outside the clean area shall meet the requirements of the current national standard GB 50140 *Code for Design of Extinguisher Distribution in Buildings*.

10.6.6 The fire extinguishing system in the chemical storage, distribution and recycle room shall be in accordance with the following requirements:

1 Water fire protection system must not be used in the rooms that stored chemicals may react with water and serious consequences will happen.

2 The fixed fire extinguishing systems should be provided in organic chemicals storage, distribution and collection rooms.

11 Electrical design

11.1 Power supply and illumination

11.1.1 The power load level and power supply requirements of the plant shall be determined by the current national standard GB 50052 *Code for Design Electric Power Supply Systems* and production process requirements.

11.1.2 The main process tools should be powered by a dedicated transformer or a dedicated low-voltage feeder. The working power with special requirements should be equipped with an uninterruptible power or other equipment to improve the quality of the power supply.

11.1.3 The low-voltage distribution voltage of the plant should be in accordance with the power requirements of the process tools. The type of live conductor system should adopt single-phase two-wire system, three-phase three-wire system and three-phase four-wire system. Grounding system should adopt TN-S or TN-C-S system. The TN-S or TN-C-S system shall be used for the grounding of the utility power and lighting system.

11.1.4 The power supply and distribution design of fire-fighting equipment shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*.

11.1.5 Power distribution equipment that is not easy to accumulate dust and is easy to wipe shall be selected in cleanrooms. The power distribution equipment should be placed in the sub-fab, and water blocking measures should be taken.

11.1.6 The power conduits in the fabrication building should be laid in air plenum or air shaft. The power conduits in the cleanroom(zone) should be laid concealed. Non-combustible materials should be used for the cable conduits. Reliable sealing measures shall be taken for the conduit end and joints between various wall mounted electrical equipment and walls in cleanrooms(zone).

11.1.7 High-efficiency fluorescent lamps should be used as cleanroom indoor lighting sources. If the process has special requirements or the illuminance does not meet the design requirements, other forms of light source may also be used.

11.1.8 The installation of general lighting fixtures in a cleanroom shall be easy for tube replacement, and it should be ceiling mounted or ceiling embedded. If embedded in the ceiling, the installation gap shall have reliable sealing measures.

11.1.9 The illuminance of the general lighting of the main production room of the cleanroom(zone) shall be determined by the requirements of process production.

11.1.10 The arrangement of the lighting fixtures in the cleanroom(zone) shall be based on the location of the process tools, and under the conditions that meet the requirements of the process production, the non-uniform layout of lighting fixtures may be used.

11.1.11 Backup lighting shall be set up in the cleanroom(zone). Backup lighting should be used as part of normal lighting and should meet the minimum illuminance required for the necessary activities and operations in the required place or location.

11.1.12 Emergency lighting for personnel evacuation should be installed in the fabrication building. Evacuation signs should be set up at safety exits, evacuation exits and the corners of evacuation passages

according to the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*. Red emergency lighting should be installed at the dedicated fire exit.

11.1.13 The cleanroom(zone) lighting shall be yellow light sources in the relevant areas according to the process production requirements.

11.2 Lightning protection and ground connection

11.2.1 The lightning protection system design of the fabrication building shall meet the requirements of the current national standard GB 50057 *Code for Design Protection of Structures Against Lightning*.

11.2.2 The functional grounding resistance value of the process tools shall not be larger than 1Ω. For equipment with special grounding requirements, the grounding resistance value shall meet the equipment requirements.

11.2.3 A common grounding system should be provided for functional grounding, protective grounding, electromagnetic compatibility grounding, and building lightning protection grounding. The grounding resistance value shall be determined by the minimum value and shall not be larger than 1Ω. According to the different functions of various grounding systems, connection line between the grounding point and the grounding device should be set separately.

11.2.4 When the decentralized grounding method is selected, the grounding bodies of various functional grounding systems shall be far away from the grounding body of the lightning protection grounding system, and the grounding poles of the separated grounding system shall keep a distance of larger than 20m from the grounding pole of the common grounding system.

11.3 Fire alarm and automatic control system

11.3.1 According to the production process layout and the installation of the utility system, the setting of the fire detector shall be in accordance with the following regulations:

1 Fire detectors shall be installed in clean production areas, air plenums, air shafts, and utility room and stations.

2 When the cleanroom(zone) adopts up supply and down return, the very early smoke detection apparatus(VESDA) system shall be installed in the return air.

3 Fire detectors shall be installed at the outlet of the air treatment equipment for make-up air or recirculation air of purifying air conditioning system.

11.3.2 The clean production area and its walkways and air plenum shall be equipped with manual fire alarm buttons.

11.3.3 The setting of the gas alarm device shall be in accordance with the following requirements:

1 Gas detectors shall be installed in the storage and distribution of flammable/toxic gases or liquids.

2 Oxygen detector shall be installed in inert gas environment.

3 Detectors shall be installed in places or equipment, gas pipeline inlet rooms, pipeline valves or joints where flammable/toxic gases or liquids may leak.

4 Gas detectors shall be installed in the air plenum or air shaft of cleanrooms with combustible/toxic gas facilities/pipelines.

5 The gas detection signal shall be interlocked with the corresponding emergency exhaust device; and the alarm signal shall be sent to the fire control room.

6 The gas alarm device shall automatically start the combustible/toxic gas shut-off valve when the exhaust fan is started.

7 The exhaust system shall be equipped with emergency power supply.

11.3.4 The plant shall be equipped with a fire duty room/control room, and the fire control room shall be equipped with a dedicated fire telephone.

11.3.5 The control, display and alarm functions of the fire control system shall meet the requirements of the current national standards GB 50016 *Code for Fire Protection Design of Buildings* and GB 50116 *Code for Design of Automatic Fire Alarm System*.

11.3.6 The security system shall verify the fire alarm of the cleanroom (zone), and shall carry out the following automatic control:

1 The indoor fire pump shall be started and receive the feedback. In addition to automatic control, manual direct control devices shall also be installed in the fire duty/control room.

2 The electrical fire damper of relevant part shall be closed, the corresponding purification air conditioning system shall be stopped, and send feedback signal.

3 The electrical fire doors and fire shutters of relevant parts shall be closed.

4 Standby emergency lighting shall be activated.

5 In the fire duty/control room or low-voltage distribution room, the non-fire power supply of the relevant parts shall be manually/automatically cut off.

6 Fire emergency speaker shall be activated for manual or automatic broadcasting.

7 The elevator shall be controlled to descend to the first floor and send feedback signal.

11.3.7 The security system shall verify the gas alarm of the cleanroom (zone), and shall perform the following automatic control:

1 The corresponding exhaust device shall be activated, and send feedback signal.

2 The automatic gas shut-off damper of the relevant part shall be activated, and send feedback signal.

11.4 Automatic control

11.4.1 The telecommunication facilities in the factory building shall be in accordance with the following requirements:

1 Telephone, wired broadcasting, structural cabling, data transmission devices and other communication facilities shall be installed.

2 Intercom telephone should be provided for production.

3 According to the needs of management and production process, closed circuit monitoring system should be provided.

4 Access control management system should be provided.

5 Clean speakers should be provided for the fire emergency public address in the cleanroom (zone).

11.4.2 The factory building shall be equipped with automatic monitoring devices for the utility systems such as the purification air-conditioning system, high-purity material supply system, heating and cooling systems, etc.

11.4.3 For the control of the static pressure difference in the cleanroom (zone), a differential pressure transmitter should be provided to control or adjust the fresh air volume or the supply air volume in the

cleanroom(zone).

11.4.4 The electric heater of the purification air-conditioning system shall be provided with windless and over-temperature power-off protection. If an electric humidifier is used, power-off protection of no water and no wind shall be provided.

12 Anti-static

12.1 General requirements

12.1.1 The anti-static working area shall be provided in TFT-LCD factory building according to production process requirements. The design of the anti-static working area shall meet the requirements of environmental control of electrostatic discharge and prevention of electrostatic hazards.

12.1.2 The design of the anti-static work area shall be graded according to the requirements of the production process of the TFT-LCD. The electrostatic potential absolute value of the anti-static work area should be less than the electrostatic potential safety value of the product.

12.1.3 The design standard of anti-static work area shall be divided into three levels. The applicable process of the design classification standard of the anti-static work area may be determined according to those specified in Table 12.1.3.

Table 12.1.3 Applicable process for design and classification standards of anti-static work areas of TFT-LCD factory building

Anti-static level	Electrostatic potential absolute value (V)	Applicable process
Class 1,2	≤100 or ≤200	Array(thin film, lithography, etching, stripping)production area. Cell(coating, friction, liquid crystal injection, cutting, edging), model production area. CF production area
Class 3	≤1 000	Assembly and debugging places for electronic components and complete machines outside the above range

12.1.4 In addition to the requirements stipulated in this chapter, the design of the anti-static work area of the TFT-LCD factory building shall also meet the requirements of the current national standard GB 50611 *Code for Design of Protection of Electrostatic Discharge in Electronic Engineering*.

12.2 Anti-static measures

12.2.1 In the anti-static working area of the TFT-LCD factory building, the anti-static ground shall be in accordance with the following requirements:

1 The surface layer of the anti-static floor shall be made of static dissipative materials, and its surface resistance should be $2.5\times10^{4}\Omega$–$1\times10^{9}\Omega$, of which the surface resistance of the first-level anti-static work area shall be $2.5\times10^{4}\Omega$–$1\times10^{6}\Omega$.

2 The anti-static ground shall be provided with an electrostatic discharge conductive layer connecting to grounding system, and its resistance to ground should be $2.5\times10^{4}\Omega$–$1\times10^{9}\Omega$.

3 The anti-static ground shall have a reliable static discharge grounding system. The grounding lead-out points of ground conductive layer shall not be less than two, and the adjacent spacing shall not be larger than 25m.

12.2.2 When the anti-static work area contains ceilings, walls, and columns, the decoration shall be in accordance with the following requirements:

1 The cover panel decorated on the ceiling, wall and column surface shall be made of static

dissipative materials. The surface resistance of the cover panel shall be $2.5\times10^{4}\Omega$–$1\times10^{9}\Omega$, of which the first-level anti-static work area shall be $2.5\times10^{4}\Omega$–$1\times10^{6}\Omega$.

2 Conductive layers shall be provided on the walls and columns of the grade Ⅰ anti-static work area. When the conductive layer is not provided on the walls and columns of the grade Ⅱ anti-static work area, anti-static coating shall be painted, or the static dissipative layer shall be decorated, and the surface resistance shall not be larger than $1\times10^{9}\Omega$.

3 When the ceiling, walls, and columns are decorated with conductive layers, a reasonable conductive layer scheme shall be worked out, with a cross-shaped copper foil or multi-point indirect grounding contacts. When the base frame is set on the ceiling, wall and column decoration, the frame shall be made of metal materials, and the metal frame should be grounded. The ground connection point shall not be less than four in each room, and the distance between adjacent connection points shall not be larger than 18m.

12.2.3 The door and window design of the anti-static work area of the factory building shall be in accordance with the following requirements:

1 The doors and windows of the class 1 and class 2 anti-static work areas shall be made of static dissipative materials or be laminated with static dissipative materials. The doors and windows of the class 3 anti-static work area may be made of low electrification materials, and the absolute value of the frictional electrification voltage shall not be larger than 1 000V.

2 When large-area glass is installed in indoor partitions and observation windows, the surface should be pasted with a static dissipative transparent film or sprayed with a static dissipative coating.

12.2.4 Other decoration design of the anti-static work area of the factory building shall be in accordance with the following requirements:

1 All kinds of decoration materials shall have surface static dissipation performance, and polymer insulating materials without surface modification treatment shall not be used.

2 The finishes of all kinds of decoration shall be smooth.

12.2.5 The air outlet and duct of the air conditioning system in the anti-static work area should be made of conductive materials and shall be grounded.

12.2.6 When using some insulating materials for the air conditioning system and various piping in the antistatic work area, tightly coupled metal mesh should be installed a on the surface of the piping, and the metal mesh shall be grounded. When using conductive non-metallic hoses, metal conductors with a tightly bonded contact area of not less than $20cm^{2}$ should be installed on the hoses, and grounding leads should be used to connect the metal conductors to the ground after reliable connection.

12.2.7 There shall be a reliable electrical connection between the air outlet, the distribution device of various pipelines and their duct and piping in the anti-static work area, and it shall be reliably grounded. Anti-static coating should be painted on the surface of the air supply port and the conveying device of various pipelines, or anti-static treatment should be performed according to the process.

12.3 Anti-static ground connection

12.3.1 The anti-static grounding connections shall be provided separately for the ceiling, wall, and ground of the anti-static work area, the operating device and instrument. The grounding connection may use clip connectors that are easy to assemble and disassemble, but the electrical connection shall be reliable.

12.3.2 An anti-static ground terminal board, a ground grid, or a closed ground copper row ring with a cross-sectional area of no less than 100mm^2 shall be installed in the anti-static work area. The anti-static ground lead shall be grounded as close as possible to the anti-static ground terminal board, ground grid, or closed copper row ring. The ground lead shall be multi-strand copper wire, and the cross-sectional area of the wire shall not be less than 1.5mm^2.

12.3.3 The anti-static grounding system shall be equipped with a general equipotential ground terminal board, floor equipotential ground terminal board, and anti-static ground terminal board before connecting to the ground. The cross-sectional area of the grounding main line drawn from the general equipotential grounding terminal board or floor equipotential grounding terminal board shall not be less than 95mm^2, and insulated shielded cables or insulated wires shall be laid through metal pipes. When the grounding main line leads to the anti-static work area, it shall be connected to the anti-static ground terminal board installed in the area. The resistance value between each connection part of the anti-static grounding system shall not be larger than 0.1Ω.

12.3.4 Anti-static measures taken in flammable and explosive environments and various liquid or gas pipelines shall still meet the requirements of the current national standard GB 50316 *Design Code for Industrial Metallic Piping*.

13 Chemicals supply

13.1 General requirements

13.1.1 The way of chemical storage and distribution in the factory building shall be determined according to the amount of chemicals required for the production process and their physical and chemical characteristics.

13.1.2 All kinds of chemicals used in the factory building shall be classified and stored according to their physical and chemical characteristics and shall meet the requirements of the current national standard GB 13690 *General Rule for Classification and Hazard Communication of Chemicals*.

13.1.3 Process tools, chemical storage areas and equipment that use hazardous chemicals in cleanroom (zone) shall take corresponding safety protection measures.

13.2 Chemicals storage and delivery

13.2.1 The chemicals of physical and chemical properties not allowed to be stored in the same area or room shall be stored separately by solid wall, the fire resistance of the adjacent room partition wall shall not be less than 2.0h.

13.2.2 The design of the chemical raw material warehouse, chemical storage room (zone) and distribution room in the factory building shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*.

13.2.3 Finished chemicals purchased and packaged separately shall be stored in an independent chemical raw material warehouse. The chemical storage should not be in a densely populated area of the plant. The stored chemical in the chemical storage should be the consumption of the chemical for seven days.

13.2.4 The chemical storage room (zone) and distribution room in the factory building shall be in accordance with the following requirements:

1 The stored chemical in the chemical storage room (zone) shall not exceed the daily consumption of production demand.

2 The flammable and explosive chemical storage room (zone) and distribution room should be independently arranged against the exterior wall, and the pressure relief area of the room shall meet the requirements of the current national standard GB 50016 *Code for Fire Protection Design of Buildings*.

3 Hazardous chemical storage areas (rooms) and distribution areas (rooms) shall not be set above, below, or adjacent to crowded rooms and evacuation walkways.

4 The chemical storage and distribution room shall be equipped with mechanical exhaust; the mechanical exhaust system shall be equipped with emergency power supply.

5 Combustible and explosive chemicals storage and distribution rooms shall have anti-static ground without sparks.

6 Corrosive chemical storage rooms and distribution rooms shall have anti-corrosion ground and anti-corrosion walls and columns.

13.2.5 Storage and distribution rooms for liquid hazardous chemicals shall be provided with overflow

protection facilities and shall be in accordance with the following regulations:

1 Drum chemical storage areas and storage tanks(groups)shall be provided with protective curbs, and the effective volume of the which shall be in accordance with the following regulations:

1) When there is no water fire extinguishing system in the drum chemical storage area and storage tank area, the effective volume of the protection curb shall be larger than the volume of the largest drum and storage tank.

2) When a water fire extinguishing system is provided in the drum chemical storage area and storage tank area, the capacity of the waste liquid collection system and the temporary emergency collection pool in the plant area shall all be considered. The total effective volume of protection curb, waste liquid collection system and temporary emergency collection pool shall not be less than the sum of the fire water consumption of 20 minutes and the volume of the largest drum and storage tank.

3) The designed height of the effective volume of the curb shall be 0.2m higher than the calculated height of Clauses 1 and 2 of this item.

2 The protective curb shall be provided between two different chemical storage tanks or tank groups that will cause chemical reactions.

3 A liquid leakage alarm and waste liquid collection system shall be provided in the protective dike.

13.2.6 The storage room and distribution room shall be equipped with emergency showers and eye washers, and a waste liquid collection system shall be installed.

13.2.7 When using manual carts to transport chemicals in cleanroom, the following requirements shall be in accordance with the following requirements:

1 Corresponding corridors and passages for the transportation of chemicals to cleanroom shall take corresponding anti-leakage safety measures according to the nature of the chemicals.

2 The carrying capacity of carts for dangerous chemicals shall not exceed 250 L; the capacity of a single container shall not exceed 20L.

3 Hazardous chemicals with incompatible physical and chemical properties shall not be transported in the same cart.

13.2.8 When a centralized chemical distribution room is provided to distribute chemicals through pipelines, be in accordance with the following requirements:

1 The distribution room shall be close to the production process area, avoiding the crowded area of the plant. It shall not be placed above, below or adjacent to crowded rooms and evacuation walkways.

2 Storage tanks, mixing tanks, daily tanks and related transportation equipment shall be classified and concentrated in independent chemical distribution rooms. The distribution room for flammable and explosive chemicals shall be separated from other rooms by solid walls.

3 The distribution room that uses large tank trucks to transport acid and alkali chemicals shall be independently arranged against the exterior wall.

4 The designed capacity of daily tanks shall not exceed the daily consumption of production requirements, and the designed volume of storage tanks transported by large tank trucks should not exceed the production requirements of 5d-7d.

5 The chemical stability of the distribution system equipment and pipelines shall be compatible with the nature of the chemicals being distributed, and the specifications, quantities and standby

conditions of the distribution pumps and filters shall be determined according to the impact of the production process dosing and the uninterrupted supply of chemicals.

6 The exhaust air of the distribution room and the supply equipment shall be classified and processed according to the nature of the chemicals, and then discharged to the atmosphere.

7 The distribution system shall be equipped with liquid level monitoring and automatic shutdown alarm devices. Overflow protection facilities shall be provided.

8 Corresponding volatile organic gas concentration alarm detectors shall be installed in the organic solvent distribution room, and shall be interlocked with the emergency exhaust system.

9 Equipment and pipelines that distribute flammable and explosive chemicals shall be equipped with anti-static grounding facilities.

10 Automatic and manual shut-off valves shall be installed on the main pipeline for distribution of flammable, explosive and corrosive chemicals.

13.3 Tube and valve

13.3.1 The material selection of the pipeline of the chemical supply system shall be determined by the physical and chemical properties and quality requirements of the delivered chemicals. Materials with good chemical stability and compatibility shall be selected.

13.3.2 In the chemical distribution pipeline system, when supplying the same chemical to multiple process tools, a valve manifold box shall be provided, and a leakage detection alarm system shall be provided.

13.3.3 The pipeline material for distribution of non-corrosive organic solvents should be low-carbon stainless steel pipes, and anti-static grounding measures shall be taken; the pipeline materials for distribution of acids, alkalis and corrosive organic solvents should be plastic pipes, and anti-leakage protective sleeves shall be provided. Gaskets for piping systems should be made of materials compatible with the chemicals being distributed.

13.3.4 The material of the valve and accessories shall be consistent with the material of the pipeline.

13.4 Waste chemicals collection and recycle

13.4.1 The waste liquid chemical system shall be in accordance with the following regulations:

1 The waste liquid chemical produced by the production process shall be set up respectively according to different varieties, and the type of the waste liquid collection system shall be determined by the amount of waste liquid.

2 Waste liquid collection system shall be provided in the chemical storage and distribution room.

3 Waste liquid collection system shall be provided in the protective curb in the storage tank area.

4 Waste liquid collection system shall be provided in the emergency shower and eye washer area.

5 The waste liquid chemical storage tanks of the centralized collection system, the external pressurizing pumps and other related equipment shall be independently installed in the chemical waste liquid collection room by the exterior wall. The flammable and explosive chemical waste liquid collection room shall be separated from other rooms by solid walls.

6 The centralized collection system shall be classified according to the waste liquid chemical composition and nature. Chemicals with incompatible physical and chemical characteristics shall not be discharged into the same waste liquid collection system.

13.4.2 The treatment method after the collection of waste liquid chemical shall be determined by the amount of chemical waste liquid and the requirements of energy saving and environmental protection, and should be treated according to the following principles:

1 Waste liquid chemical with small-volume discharge should be recycled in the plant or collected in drums by classification, and be treated by entrusted licensed hazardous waste operation company.

2 Waste liquid chemical with large-volume discharge should be classified and collected by centralized storage tanks, recycled, purified and reused in the plant or treated by entrusting licensed hazardous waste operation company.

13.4.3 Waste liquid collection system shall be provided in the outdoor tank truck parking area and the drum chemical area, and the waste liquid must not be discharged into the outdoor rainwater system.

14 Space management

14.1 General requirements

14.1.1 Space management design shall be in accordance with the following requirements:

1 The layout, operation, maintenance and main piping of the process tools shall meet the minimum safety distance and occupied elevation.

2 The layout, operation, maintenance and main piping of the equipment for general water supply and drainage, pure water, process cooling recirculation water, waste water treatment, fire protection shall meet the minimum safety distance and occupation elevation.

3 The layout, operation, maintenance and main piping of the equipment for purification, heating, air supply, exhaust, chilled water shall meet the minimum safety distance and occupation elevation.

4 The layout, operation, maintenance and main piping of the equipment for cooling and heating source, bulk gas supply, compressed air station, vacuum pump room, special gas station shall meet the minimum safety distance and occupation elevation.

5 The layout, operation, maintenance and main piping of the equipment for chemical supply and recycle shall meet the minimum safety distance and occupation elevation.

6 The layout of the electrical equipment and lighting fixtures, as well as the cable tray, bus bar and conduit shall meet the minimum safety distance and occupation elevation.

14.1.2 The clear height of the clean production floor shall be determined by factors such as the size of process tools and material handling equipment, micro-environmental equipment and clean air flow control. Array, CF and Cell area should not be less than 4m, module area should not be less than 3m.

14.1.3 The clear height of the sub-fab shall be determined according to factors such as the size of the process auxiliary equipment and its move-in height, pipeline layout, clean air flow control, etc., and should not be less than 4m.

14.1.4 The clear height of the ceiling plenum shall be determined by factors such as air conditioning equipment, pipeline layout, clean air flow control, etc., and should not be less than 3m.

14.2 Pipeline layout

14.2.1 The pipeline layout shall be in accordance with the following requirements:

1 The pipeline layout shall meet the production process, safety spacing and maintenance requirements.

2 Pipeline layout shall not affect the process tools move-in and material transportation.

3 The clearance between pipelines, between pipelines and building walls, trench walls or columns shall meet pipeline installation and operation requirements.

4 Various pipelines should be arranged in rows, and single-row pipelines shall be grouped according to pipeline materials and pressure and gravity pipelines.

5 Gravity pipelines shall be arranged first, and pressure pipelines shall avoid gravity pipelines.

14.2.2 The minimum clearance between pipelines, between pipelines and buildings and structures shall meet the installation and construction requirements of pipelines and pipeline accessories, and shall

meet the requirements of the current national standards GB 50316 *Design Code for Industrial Metallic Piping*, GB 50015 *Standard for Design of Building Water Supply and Drainage*, GB 50217 *Standard for Design of Cables of Electric Power Engineering*, GB 50054 *Code for Design of Low Voltage Electrical Installations*, GB 50030 *Code for Design of Oxygen Station*, GB 50177 *Design Code for Hydrogen Station*.

14.2.3 Special gas pipelines and chemical supply pipelines should be arranged in a row, and should be arranged in the tray, the clearance between the tray and other pipelines should not be less than 200mm.

14.2.4 The pipeline installed on the floor shall meet the installation requirements of valves and fittings, etc. The bottom of the pipe or the insulation layer shall not be less than 150mm from the ground.

14.2.5 Pipelines in areas with micro-vibration control requirements shall adopt appropriate vibration isolation measures in accordance with micro-vibration control requirements.

14.2.6 The pipeline in the air plenum shall be in accordance with the following requirements:

1 The layout of air plenum pipelines shall be planned in accordance with the layout of process tools.

2 Air plenum pipeline layout shall reserve maintenance access.

3 The layout of the sub-fab pipeline shall meet the requirements of the installation and move-in of process auxiliary equipment.

4 The layout of the ceiling plenum pipeline shall meet the installation and maintenance requirements of the air filter unit.

5 The layout of the ceiling plenum pipeline shall avoid clean crane structural components.

14.2.7 Main pipelines and sub-main pipelines should not be arranged in the clean production area. The pipelines arranged in the clean production area shall meet the operation and maintenance requirements of the process tools.

14.3 Pipe supports and hangers

14.3.1 Common supports and hangers should be provided when pipelines are arranged in parallel.

14.3.2 The setting of shared pipe support and hanger shall not affect the operation and maintenance of equipment and pipes.

14.3.3 The setting and spacing of common pipeline support and hangers shall be determined by the minimum spacing of all pipelines in parallel and economic factors. Strength and stiffness calculation shall also be performed.

14.3.4 Standard products should be used for common pipe supports and hangers.

14.3.5 The shared pipe support and hanger should be fixed on the beam and column of the structure.

Appendix A Typical TFT-LCD process flow

A.0.1 The fabrication process of TFT-LCD(Figure A.0.1)shall include Array, CF and Cell.

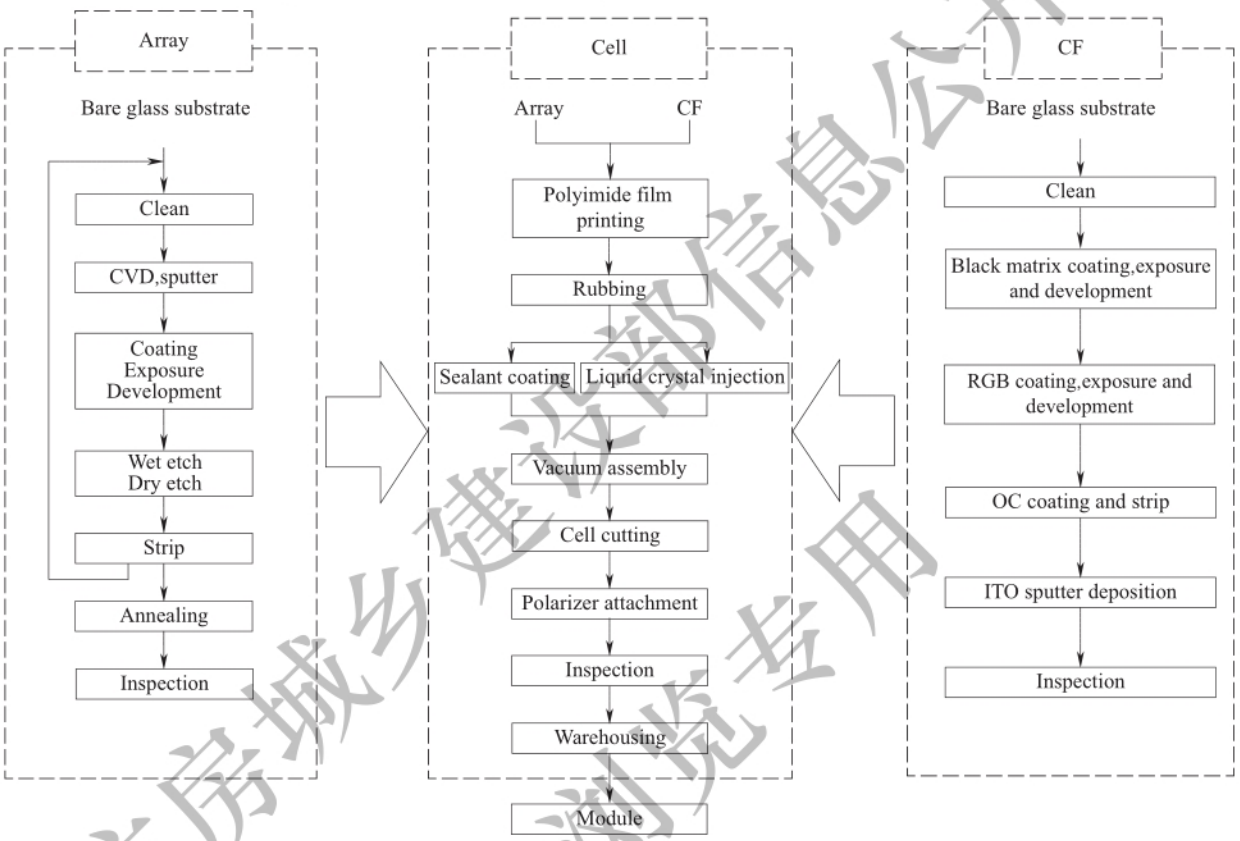

Figure A.0.1 Diagram of process flow of TFT-LCD

A.0.2 The module process of TFT-LCD(Figure A.0.2) shall include cleaning, polarizer attaching, bonding, backlight assembly, testing and aging.

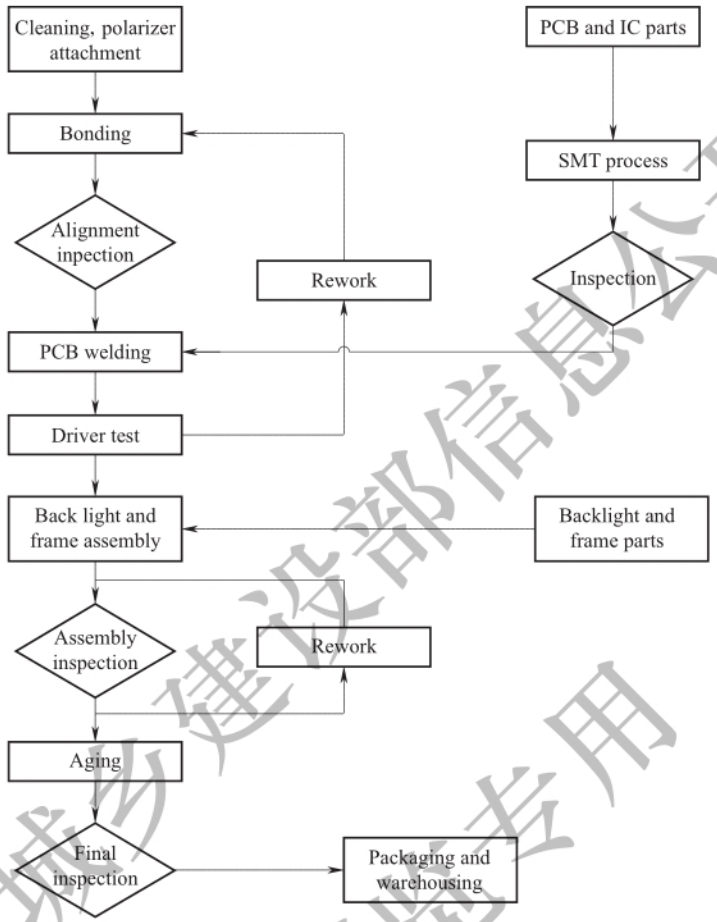

Figure A.0.2 Diagram of process flow of module

Appendix B Standard vibration control curve

B.0.1 The micro-vibration control curve may be selected according to the general vibration standard curve(Figure B.0.1).

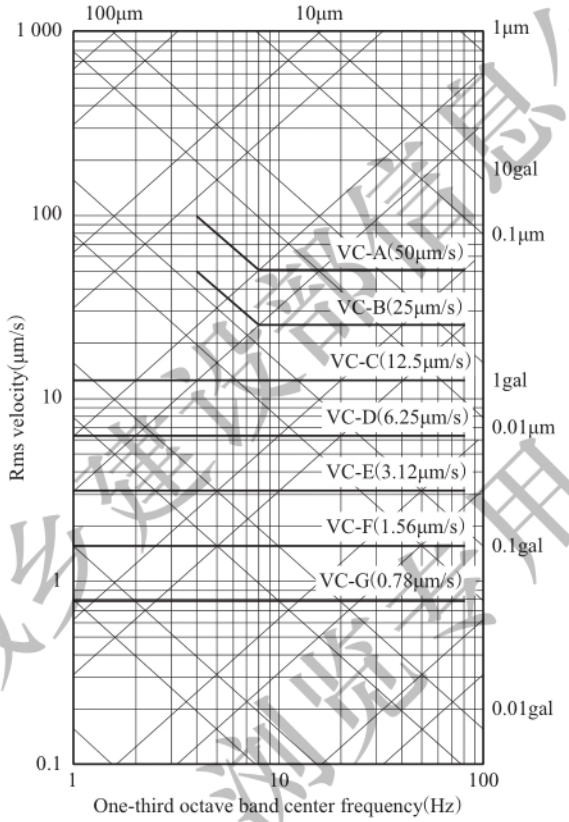

Figure B.0.1 General vibration standard curve(VC curve)

Note:"Rms"on Y-axis is root mean square.

B.0.2 The standard value of micro-vibration control may be designed according to Table B.0.2.

Table B.0.2 Digital definition of general vibration standard curve

Standard	Definition
VC-A	4 Hz–8Hz:0.25gal;8Hz–80Hz:50μm/s
VC-B	4Hz–8Hz:0.125gal;8Hz–80Hz:25μm/s
VC-C	1Hz–80Hz:12.50μm/s
VC-D	1Hz–80Hz:6.25μm/s
VC-E	1Hz–80Hz:3.12μm/s
VC-F	1Hz–80Hz:1.60μm/s
VC-G	1Hz–80Hz:0.78μm/s

Explanation of wording in this code

1 Words used for different degrees of strictness are explained as follows in order to mark the differences in implementing the requirements of this code.

1) Words denoting a very strict or mandatory requirement:

"Must" is used for affirmation, "must not" for negation.

2) Words denoting a strict requirement under normal conditions:

"Shall" is used for affirmation, "shall not" for negation.

3) Words denoting a permission of a slight choice or an indication of the most suitable choice when conditions permit:

"Should" is used for affirmation, "should not" for negation.

4) "May" is used to express the option available, sometimes with the conditional permit.

2 "Shall comply with..." or "shall meet the requirements of..." is used in this code to indicate that it is necessary to comply with the requirements stipulated in other relative standards.

List of quoted standards

GB 50015 *Standard for Design of Building Water Supply and Drainage*
GB 50016 *Code for Fire Protection Design of Buildings*
GB 50019 *Design Code for Heating Ventilation and Air Conditioning of Industrial Buildings*
GB 50030 *Code for Design of Oxygen Station*
GB 50052 *Code for Design Electric Power Supply Systems*
GB 50054 *Code for Design of Low Voltage Electrical Installations*
GB 50057 *Code for Design Protection of Structures Against Lightning*
GB 50073 *Code for Design of Clean Room*
GB 50084 *Code for Design of Sprinkler Systems*
GB 50116 *Code for Design of Automatic Fire Alarm System*
GB 50140 *Code for Design of Extinguisher Distribution in Buildings*
GB 50177 *Design Code for Hydrogen Station*
GB 50187 *Code for Design of General Layout of Industrial Enterprises*
GB 50193 *Code of Design for Carbon Dioxide Fire Extinguishing Systems*
GB 50201 *Standard for Flood Control*
GB 50217 *Standard for Design of Cables of Electric Power Engineering*
GB 50222 *Code for Fire Prevention in Design of Interior Decoration of Buildings*
GB 50243 *Code of Acceptance for Construction Quality of Ventilation and Air Conditioning Works*
GB 50316 *Design Code for Industrial Metallic Piping*
GB 50370 *Code for Design of Gas Fire Extinguishing Systems*
GB 50472 *Code for Design of Electronic Industry Clean Room*
GB 50611 *Code for Design of Protection of Electrostatic Discharge in Electronic Engineering*
GB 50646 *Technical Code for Specialty Gas System Engineering*
GB 50685 *Code for Design of Pure Water System of Electronic Industry*
GB 50710 *Code for Design of Energy Conversation of Electronic Industry*
GB 50724 *Technical Code for Bulk Gas Purification and Delivery System Engineering*
GB 13271 *Emission Standard of Air Pollutants for Boiler*
GB 13690 *General Rule for Classification and Hazard Communication of Chemicals*
GB 16297 *Integrated Emission Standard of Air Pollutants*
GB 19577 *The Minimum Allowable Values of the Energy Efficiency and Energy Efficiency Grades for Water Chillers*