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深圳市设施农业行业协会团体标准

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人工光型植物工厂建设规范

Specifications for Construction of Artificial Irradiating Plant Plants

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前 言

植物工厂的生产体系决定了所种植的蔬菜是至今为止所有蔬菜中食品安全级别最高的蔬菜，这种生产体系是由植物工厂种植设备与种植工艺共同实现的，这种生产体系也充分保证了植物工厂种植的蔬菜具有优异的蔬菜营养指标，为了保证所有植物工厂能完整地符合这种生产体系，我们制定了人工光型植物工厂建设规范。

本标准从植物工厂选址、厂房建设、设备制造、种植工艺、安全生产、蔬菜品质检验、蔬菜包装与运输、产品质量保证期等制定了系统性的规范，从而确保蔬菜的食品安全与营养品质的可溯源性；有助于植物工厂健康的发展。

本标准也符合有价营养成分、生化指标以及重金属、农药残留等要求严格的种植厂房建设参考。

本标准由佛山好亮固体光源研究所、北京大学深圳研究生院、中山善栽农林科技有限公司提出。

本标准起草单位：深圳市设施农业行业协会、福建省中科生物股份有限公司、江苏唐城霓虹数码科技有限公司（江苏唐城生物照明有限公司）、深圳市伊光农场生态科技有限公司、富士康科技集团、深圳市超频三科技股份有限公司、厦门迈信物联科技股份有限公司、杭州益昊农业科技有限公司、深圳市海卓生物科技有限公司、广东华辉煌光电科技有限公司、深圳一诺照明实业有限公司、江门市廖氏照明科技有限公司

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参与本标准修改，并提出过意见和建议的单位：中国农业科学院农业环境与可持续发展研究所、清华大学深圳研究生院、华南农业大学、北京大学深圳研究生院、天津理工大学、深圳信息职业技术学院

参与本标准修改，并提出过意见和建议的专家：杨其长、马建设、刘厚诚、王达健、吴启保。

人工光型植物工厂建设规范

1 范围

本标准用于人工光型植物工厂和集装箱型工厂的建设规范；对于混合光型植物工厂、太阳光型植物工厂、植物栽培柜等可部分参考本规范；本标准制定了人工光型植物工厂的厂房选址、建造、装修、种植设备、营养液与基质、品质检测、包装材料、安全生产等技术规范；是人工光型植物工厂建设的标准性文件，本标准适用的植物包括叶菜类蔬菜、瓜果类蔬菜、中草药、鲜花、温室果树等经济作物需要工业化种植的建设规范。

2 规范性引用文件

下列文件中的条款通过本标准的引用而成为本标准的条款。凡是标年份的引用文件，其随后所有的修改单（不包括测量的内容）或修订版均不适用本标准，然而，鼓励根据本标准达成协议的各方研究是否可使用这些文件的最新版本。凡是不注年份的引用文件，其最新版本适用于本标准。

通用标准：

GB/T 1.1-2009 标准化工作导则第 1 部分：标准的结构和编写

T/SZFAA 01-2018 植物人工辐射源光谱参数规范

GB2822-2005 标准尺寸

其他标准引用在条款中体现

注：由于植物工厂需要引用不同技术学科的标准，为了更好的应用本标准，具体不同专业标准在相关条款中引用。

3 术语和定义

本标准采用下列术语和定义：

3.1

植物工厂

植物工厂（Plant Factory）是设施农业发展的高级阶段，是农业种植工业化生产的形式，是综合种植环境的自动化控制、电子技术、传感器技术、物联网、生物技术、机器人、新材料及光电器件等学科的技术应用，目的是实现植物全年订单化连续生产，是采用计算机与物联网对植物生长的光照、农艺措施、二氧化碳浓度、温度、湿度、通风、消毒灭菌等生产过程进行控制，构造以科学为基础且独立于经验和直觉的新型农业种植方式。

植物工厂按照光辐射方式分三种类型，人工光型植物工厂，混合光型植物工厂，太阳光型植物工厂。

3.2

人工光型植物工厂

主要以人工制造的光源向植物生长过程提供光辐射的植物工厂。

3.3

混合光型植物工厂

主要以太阳光与人造光源叠加向植物生长过程提供光辐射的植物工厂。

3.4

太阳光型植物工厂

主要以太阳光向植物生长过程提供光辐射的植物工厂。

3.5

光谱量子分布 Spectral Quantum Distribution（SQD）

由植物灯的光谱功率分布（SPD）计算出来的光谱量子分布曲线。

3.6

SQD 峰值

光谱量子分布曲线的光子微摩尔的最大值，单位：μ mol/(λ .s)。

3.7

种植工艺

植物从种子发芽到收获全过程施加的农艺措施，是为种植过程制定的生产工艺。

3.8

供给光量

植物种植工艺要求的植物灯必需提供的光子通量密度的最小值，单位：μ mol/m^2s。

注：植物灯的测量光子通量密度（MPFD）必须大于供给光量。

3.9

种植基质

代替土壤向植物提供支撑和固定根系的固体介质，种植基质包括无机基质与有机基质。

3.10

有机基质

有机基质是一类由非土壤组成的有机物料经过无害化处理形成的栽培介质，也可以是以这些有机物料为主，混配其他物料后组成的复合物。

3.11

营养液

营养液是以液态方式提供植物生长所需要的水和养分，营养液包括有机营养液和无机盐营养液，或者有机无机复混的全营养液。

3.12

种植架

有立柱片、横梁（或悬臂梁）等承载构件组成，用于支撑和固定种植设备的多层框架。

3.13

植物工厂第三方确认

由植物工厂签订合同中规定的委托第三方专家团队进行合同技术条款、生产设备技术性能、技术可行性、技术先进性等进行符合标准化与规范化的技术性确认，植物工厂第三方确认是合同授权的最终技术确认。

允许合同双方自行协商验收确认，需要合同注明。

4 植物工厂建设规范

4.1

植物工厂选址要求

4.1.1 选址环境空气质量要求

植物工厂选址环境空气中氮氧化物（NOx）、挥发性有机物（VOCs）、臭氧（O_3）、细颗粒物（PM2.5）、可吸入颗粒物（PM10）、总悬浮颗粒物（TSP）、铅、飘尘中苯并[a]芘（BaP）等浓度限定值按照《GB 3095-2012 环境空气质量标准》第 4.2 项表 1 与表 2，区分一类区和二类区。

尽量选址在一类区域。

对于选址在二类区，需要取得当地的环评报告，并提交备案。

选址在二类区，通风设备需要增加相应的 PM 2.5 过滤设备。

不允许选址在有害气体排放区域。

PM2.5 过滤设备过滤质量检验按照《HJ 618-2011 环境空气 PM10 和 PM2.5 的测定 重量法》全部条款执行

环评报告的各项污染物分析方法符合《GB 3095-2012 环境空气质量标准》中第 5.3 项的分析方法要求，数据有效性符合第 6 项表 4 要求。

允许采用当地政府提供的环境空气评估报告代替实际测量，并提交备案。

4.1.2 选址环境质量要求

优先选择空气通畅、水质纯净、土壤未受污染、具有良好生态环境的地区，应尽量避开污染源地区。

选址的用水质量要有保证，选址应选择在地表水、地下水水质清洁无污染的地区;水域或水域上游没有对该产地构成污染威胁的污染源。

非生产用水符合标准《CJ/T 206-2005 城市供水水质标准》中第 4.1.1-4.1.3 项要求，水质检验项目符合第 4.2.1 的表 1 要求，水质检验频率符合第 6.7 项表 3 中检验频率要求。

不允许选址在有毒离子和有害物质倾倒物富集。

不允许选址在重金属离子：汞、镉、铬、铅、砷、铜、锌、氟等富集区域。

厂房土壤与大气降尘重金属的重金属元素总量不得超过表 1。

表 1 土壤重金属污染风险筛选值

序号	元素	风险筛选值（mg/kg）	适合性
1	镉（Cd）	≤0.3	土壤的 5.5≤pH≤6.5
2	汞（Hg）	≤1.8	
3	砷（As）	≤40	
4	铅（Pb）	≤90	
5	铬（Cr）	≤150	
6	铜（Cu）	≤50	
7	镍（Ni）	≤70	
8	锌（Zn）	≤200	

检测方法参考标准《GB 15618-2018 土壤环境质量 农用地土壤污染风险管控标准》中第 7.2 项表 4 执行。

对于土壤 pH 值不符合表 1 要求的，参考《GB 15618-2018 土壤环境质量 农用地土壤污染风险管控标准》中第 4.1.1 项。

对于选址要求高的植物工厂，可以参考执行《NY/T 391—2013 绿色食品 产地环境质量》中第 4 项、第 7.1 项表 7 的要求。

4.2

厂房设计与装修要求

新设计厂房符合标准《GB 50073—2001 洁净厂房设计规范》全部要求。

旧厂房改造符合标准《GB 50325-2013 民用建筑工程室内环境污染控制》中第 3.1 项、3.2 项、3.3 项、3.4 项、3.5 项、3.6 项。

新旧厂房建筑材料同时需要符合标准《GB 6566-2010 建筑材料放射性核素限量》全部要求。

厂房给排水参考标准《GB 50015-2010 建筑给排水设计规范》相关要求。

厂房送配电执行标准《JGJ16－2008 民用建筑电气设计规范》相关要求。

厂房防雷设计符合标准《GB 50057－2011 建筑物防雷设计规范》要求。

工厂非生产空间照明参考标准《GB 50034－2013 建筑照明设计标准》中第 7 项要求。

植物工厂装修要求：

所有装修材料符合 CCEL 国家环保认证。

装修材料符合标准《GB 50325-2013 民用建筑工程室内环境污染控制》中第 3.1.2 项、3.3.5 项、3.4 项、3.5 项、3.6 项要求。

厂房内地面防水处理材料与标识材料要符合 CCEL 国家环保认证。

地面要做区域与通道标识。

区域标识符号要与墙面和地面颜色有明显区别，具体颜色不限制。

植物工厂交付使用时，厂房内总挥发性有机化合物 TVOC≤2 mg/m^3

室内装修装饰后，有害物质符合标准《DB13/3005—2017 建筑类涂料与胶粘剂挥发性有机化合物含量限值标准》中第 4 项表 1 要求。

厂房建筑交付使用前需要进行环评指标的植物工厂第三方确认。

无环评指标确认不得进行设备安装，本项规定为强制性规定。

4.3

无尘厂房等级规范

植物工厂建立的无尘厂房标准按照表 2 执行，表中有 ISO14644-1 等级对应关系。

无尘厂房等级选取需要根据植物工厂种植品种与种植工艺确定，不低于 10 万级（ISO Class8）。

检验参考标准《GB 50073—2001 洁净厂房设计规范》附录 C 要求。

表 2：无尘厂房空气洁净度要求和微生物、沉降菌要求

等级/ISO14644-1	尘粒最大允许数/立方米 ≥0.5μ m 尘粒数	≥5μ m 尘粒数	微生物最大允许数 浮游菌/立方米	沉降菌/皿
100 级 ISO Class5	≤3500	0	5	1
1000 级 ISO Class6	≤35000	≤250	100	3
10000 级 ISO Class7	≤350000	≤2500	500	10
100000 级 ISO Class8	≤3500000	≤25000	1000	15

注：采用 ISO 等级需要提供引用项说明。

4.4

无尘厂房的消毒灭菌

不允许采用有附着性的消毒灭菌材料。

微生物最大允许数与沉降菌要求执行消毒灭菌。

灭菌设备需要符合 CCEL 国家环保认证。

采用紫外线灭菌符合标准《GB 15981-1995 消毒与灭菌效果的评价方法与标准》中第二篇 紫外线表面消毒效果评价方法与标准执行。

采用臭氧灭菌按照下述要求：

空气中释放的臭氧浓度：3-5 ppm。

营养液消毒灭菌的臭氧量为 2.5-3.5 mg/L。

臭氧灭菌臭后，车间内空气中臭氧浓度低于 0.1 ppm 才能符合工作条件。

采用液体消毒剂消毒按照《GB 15981-1995 消毒与灭菌效果的评价方法与标准》中第三篇 液体消毒剂消毒效果评价方法与标准。

无尘厂房消毒灭菌期间，严禁厂房内蔬菜种植（包括蔬菜存放）和人员滞留。

4.5

植物工厂通风要求

通风设备空气过滤等级要符合 4.3 无尘等级规范中的表 2 要求。

建筑通风要求符合标准《GB 50352-2005 民用建筑设计通则》中第 7.2 项要求

通风设备工作时间要求：

通风空间体积：空间体积=厂房面积×厂房高度，单位：m^3。

通风量，单位：m^3/hr。

根据空间体积与通风量按下式计算通风时间 hr：

hr=K×空间体积/通风量，单位：hr，其中：K-置换系数（1-4）。

通风工作时间要求：通风时间≤1.2 hr，允许多台通风设备并行工作。

通风设备需要符合下面要求：

出口风压，单位：Pa，出口风压≤150 Pa。

距离通风设备 1m 处，设备噪音≤50 db。

厂房内进风口需要检测进风的二氧化碳浓度、温度与湿度。

厂房内出风口需要检测出风的二氧化碳浓度、温度与湿度。

通风期间，室内温度平均值符合种植工艺标称温度的±6℃。

通风期间，室内二氧化碳浓度与湿度不限制。

通风用过滤器等级按照表 3 执行。

过滤器分级	初效	中效	高中效	亚高效
粒径(μ m)	≥5.0	≥1.0		≥0.5
记数效率（%）	20≤E＜80	20≤E＜70	70≤E＜99	95≤E＜99.9

注：允许采用 EN779 与 EN1882-1 标准

进风空气过滤器参考标准《GB/T 14295-2008 空气过滤器》与《GB T 13554-2008 高效空气过滤器》。

过滤器性能试验方法参考标准《GB T 6165-2008 高效空气过滤器性能试验方法 效率和阻力》。

对于厂房面积大于 1000 平方米的通风，需要采取空气质量预处理房进行处理后再向厂房内输送，送风设备参考标准《GB/T 23174-2008 排风扇》。

室内出风通风设备参考标准《GB/T 23174-2008 排风扇》。

室内出风与进风的通风设备不工作时，室外空气不得通过通风设备进入厂房内。

4.6

安全与消防

植物工厂依据国家消防法规执行下列标准：

中华人民共和国消防法，消防监督检查规定。

符合标准《GB 50016-2014 建筑设计防火规范》中第 3 项要求。

建设单位需要向公安机关消防机构申请消防设计审核，并在建设工程竣工后向出具消防设计审核意见的公安机关消防机构申请消防验收。

需要提供当地公安消防部门验收文件后，植物工厂第三方确认才能进行。

5 设备规范

设备规范是对植物工厂建设的设备基本要求，具体设备选择需要依据植物工厂种植工艺制定。

5.1

种植架设计要求

种植架设计的高度、宽度、层高、布置排列等首先要符合种植工艺要求。

种植架的整体强度、稳定性分析、承载能力需要提供设计计算书备案。

种植架最大横梁长度≤3 m。

5.1.1

种植架高度＞4 m，单元载荷≤1500 Kg 参考下列标准：

符合标准《GB/T 28576-2012 工业货架设计计算》中第 4.1.2 项牛腿式货架与第 4.3 项普通托盘货架进行设计。

种植架高度＞10 m，单元载荷≥400 Kg，需要提供有限元整体分析报告，提供有限元分析报告不需要进行稳定性校核计算。

采用冷弯薄壁型钢构件符合标准《GB 50018-2002 冷弯薄壁型钢结构技术规范》各项要求。

种植架：高度/宽度≥7 时，种植架之间需要增加龙门梁，需要进行稳定性校核计算，并提供种植架稳定性计算书备案。

稳定性校核计算参考,标准《GB/T 28576-2012 工业货架设计计算》第 9 项要求，符合《GB 50018-2002 冷弯薄壁型钢结构技术规范》中第 5.3 项、5.5 项、10.1.6 项要求。

稳定性系数参考附录 A 表 A.1.1-2 项、A.2 项。

种植架每层横梁变形要求：8 年内中心挠度 h≤4.5 mm/m。

种植架尺寸优先选用标准《GB2822-2005 标准尺寸》中的 R 系列。

不允许采用非金属材料制造种植架。

5.1.2

种植架高度≤4 m，单元载荷≤900 Kg 参考下列标准：

符合标准《SB/T 10166-1993 金属轻型组合货架》中第 4.1 项双柱支承型组合货架和四柱支承型组合货架进行设计。

产品规格系列及尺寸要求符合《SB/T 10166-1993 金属轻型组合货架》第 4.3 项表 1 规定。

装配质量符合《SB/T 10166-1993 金属轻型组合货架》第 5.6 项要求，尺寸公差符合第 5.6.2.3 项表 3 要求。

采用冷弯薄壁型钢构件符合标准《GB 50018-2002 冷弯薄壁型钢结构技术规范》各项要求。

种植架：高度/宽度≥7 时，种植架之间增加龙门梁，并提供种植架稳定性计算书备案。

稳定性校核计算参考,标准《GB/T 28576-2012 工业货架设计计算》第 9 项要求，符合《GB 50018-2002 冷弯薄壁型钢结构技术规范》中第 5.3 项、5.5 项、10.1.6 项要求。

稳定性系数参考附录 A 表 A.1.1-2 项、A.2 项。

种植架每层横梁变形要求：8 年内中心挠度 h≤4.5 mm/m。

种植架设计尺寸符合标准《GB2822-2005 标准尺寸》中的 R 系列。

允许采用非金属材料制造种植架，需要符合 5.1.2 相关要求。

5.2

种植架防腐蚀

防腐涂料底料、面漆材料符合 CCEL 国家环保认证。

符合标准《GB 50018-2002 冷弯薄壁型钢结构技术规范》中第 11.2 项要求。

防腐涂料底料、面漆维护年限参考标准《GB 50018-2002 冷弯薄壁型钢结构技术规范》中附录 D 表 D.0.2。

5.3

种植架防护涂层挥发性有机化合物 VOC

种植架防锈油漆应符合 CCEL 国家环保认证要求。

植物工厂交付使用时，种植架中心处的总挥发性有机化合物 TVOC≤0.8 mg/m^3。

具体限值参考标准《DB13/3005—2017 建筑类涂料与胶粘剂挥发性有机化合物含量限值标准》中第 4 项表 1 要求。

注：由于挥发性有机化合物 VOC（Volatile Organic Compound）在一定条件下可以参加大气光化学反应的有机化合物，会产生其他环节污染问题。

5.4

种植架安全检查

符合标准《GB/T 33454-2016 仓储货架使用规范的项要求》中第 6.1-6.2.3.2 各项要求。

植物工厂建成后每 6 个月检查一次，必要时增加重点检查项目。

5.5

种植架每层通风

种植架每层通风不是必须设置，需要依据种植工艺提出的要求。

如需要通风，符合以下要求：

种植架每层风速调控范围：0.5-4 m/min。

种植架每层通风风机噪音≤15 db（出风口 0.2 m 处）。

5.6

种植架平面布置与主通道

种植架平面布置需要符合植物工厂通风顺畅与方便操作的要求，种植架之间的工作通道与主通道符合操作安全原则。

种植架与建筑墙壁的距离≥0.5 m，目的是防止迁移性菌害。

对于金属结构件构成的箱体式植物工厂，对迁移性菌害采取了有效防护措施下；允许种植架贴近箱体墙面布置。

种植架的间距按照种植架宽度进行比例设计，以操作方便为原则，但不低于 0.6 m。

主通道要求：不得低于运输设备要求的最小宽度。

主通道地面需要标识，颜色不限制。

5.7

种植架间自动化操作设备要求

非轨道类设备两边距离种植架距离不低于 0.3 m。

轨道类设备两边距离种植架距离不低于 0.2 m。

自动化操作设备的高度/宽度≥3 时，需要提供设备的稳定性计算书备案。

5.8

种植架用灯具

灯符合标准《T/SZFAA 01-2018 植物人工辐射源光谱参数规范》各项要求。

测试报告符合《T/SZFAA 01-2018 植物人工辐射源光谱参数规范》附录 A 要求。

光源光谱符合种植工艺光谱要求。

植物灯光谱参数必须满足种植工艺要求的供给量。

10000 hr 光源 SQD 峰值偏移≤3 nm。

10000 hr 光源 PPF 衰减量≤10 %。

计算 PPF 衰减量的初始值是种植工艺光谱参数要求的供给光量。

多层种植架用植物灯不推荐采用风冷与水冷式散热。

混合光型植物工厂允许采用风冷和水冷散热。

人工光型植物工厂植物灯 IP 不得低于 IP53。

混合光型植物工厂植物灯 IP 不得低于 IP65。

灯具外壳防护及 IP 代码参考标准《GBT 4208-2017 外壳防护等级（IP 代码）》，灯具外壳防护一般要求符合第 11-15 各项要求。

需要提供灯具电气连接图备案。

灯具材料符合 CCEL 国家环保认证要求。

灯具安全性能执行标准《GB 7000.1-2015 灯具　第 1 部分：一般要求与试验》相关要求。

灯具电气性能执行标准《GB 17625.1 电磁兼容 限值 谐波电流发射限值(设备每相输入电流≤16A)》相关要求。

灯具电磁性能执行标准《GB 17625.2-11 电磁兼容试验和测量技术》相关要求。

采用无线网络控制的植物灯，需要提系统资料备案。

5.9

二氧化碳浓度控制

植物工厂二氧化碳平均浓度控制能力范围在 600-1800 ppm 之间。

具体二氧化碳浓度值控制量由种植工艺提出参数。

化学反应产生二氧化碳的设备不得置于种植厂房内，二氧化碳气体采用管道输送。

二氧化碳浓度检测探头每 20 m^2 不得少于 1 个，测量精度≤±5%,测量传感器需要定期校准。

二氧化碳探头精度与使用寿命需要提供参数备案，此备案为生产事故分析备案。

工作人员在现场操作时，二氧化碳浓度≤2000 ppm,本项为强制规定。

5.10

温度与湿度控制

植物工厂生产室内温度控制能力范围在：18-30℃。

植物工厂生产室内相对湿度控制能力范围在，RH：50-90%。

具体温度与湿度值控制依据种植工艺提出参数。

温度检测探头每 30 m^2 不得少于 1 个，测量精度≤±1℃,测量传感器需要定期校准。

湿度检测探头每 50 m^2 不得少于 1 个，测量精度≤±4%RH,测量传感器需要定期校准。

温度、湿度探头精度与使用寿命需要提供参数备案，此备案为生产事故分析备案。

空调能效比计算，包括 EER 与 COP。

制冷能效比（EER）=制冷量（W）/制冷消耗功率（W）。

制热能效比（COP）=制热量（W）/制热消耗功率（W）。

要求空调设备能效等级≥3 级。

能效等级参考标准《GB 12021.3-2010 房间空气调节器能效限定值及能效等级》与《GB 21455-2013 转速可控型房间空气调节器能效限定值及能效等级》

5.11

管路管件要求

生产用管路管件需要提供流量、压力压强、耐温的设计计算书备案。

提供管路管件布置图备案。

生产用管路的进口与出口需要有截止阀控制。

除排污外不得采用沟槽管件。

采用电磁控制阀门需要提供电气图备案。

生产用管路管件采用原材料要达到食品级要求，特殊要求可采用卫生级。

生产用金属阀门与水或营养液接触部分的材料要达到食品级要求，特殊要求可采用卫生级。

生产用管路管件制成材料需要提供检测报告备案。

5.11.1

材料适用标准

材料符合下列国家标准要求：

符合《GB 4806.1-2016 食品安全国家标准 食品接触材料及制品通用安全要求》中第 3.1 和第 3.2 的要求。

符合标准《GB 4806.7-2016 食品安全国家标准 食品接触用塑料材料及制品》各项要求。

符合标准《GB 4806.9-2016 食品安全国家标准 食品接触用金属材料及制品》中表 1、表 2、表 3 各项指标要求。

5.11.2

迁移试验执行标准

符合标准《GB 5009.156-2016 食品用包装材料及其制品的浸泡试验方法通则》各项要求。

符合标准《GB 31604.1-2015 食品接触材料及制品迁移试验通则》各项要求。

符合标准《GB 31604.9-2016 食品安全国家标准 食品接触材料及制品 食品模拟物中重金属的测定》各项要求。

5.12

种植槽（管）与种植箱材料要求

此项材料要求包括种植蓝、种植板、种植棉等。

种植槽（管）与种植箱的最长尺寸 3 年内中心挠度 h≤0.004×最大尺寸，单位：mm。

种植槽（管）、种植箱、种植蓝、种植板、种植棉等材料应符合 CCEL 国家环保认证要求。

水培种植槽与种植箱制成材料与实验应符合第 5.11.1 与第 5.11.2 的要求。

上述制成材料需要提供检测报告备案。

5.13

营养液储存箱要求

种植液容积=种植槽（箱）工作容积+输送管道容积。

营养液储存箱容积≥1.5×种植液容积.

水培营养液储存箱需要安装可视液位计和液位传感器。

水培营养液储存箱需要符合人工可清洗要求。

水培营养液储存箱不得置于无消毒灭菌环境。

营养液抽排设备不得置于储存箱内。

水培营养液储存箱材料与实验应符合第 5.11.1 与第 5.11.2 的要求。

水培营养液储存箱制成材料需要提供检测报告备案。

5.14

无机盐营养液回流紫外线灭菌

紫外线峰值波长在：250-270 nm 之间，标准峰值波长：253.7 nm。

紫外线灯光置于液面上方 0.1-0.2 m 处均匀排布，液位高度小于 0.15 m。

液面紫外线有效剂量（灯管无垢时测量）≥70 mJ/cm^2。

液体经过紫外线辐射区域时间（s）：3≤s≤10。

紫外线灯为无臭氧型，实际使用会产生少量臭氧，应符合臭氧产量≤1mg/hr，可单独设置通风设备。

紫外线消毒适合温度范围是：20-40℃。

紫外线辐射量低于初始值 70%，应及时更换，此限定是灯管表面不包含有水垢。

紫外线灯管应定期消除水垢。

紫外线消毒检测方法参考标准《GB/T 19857-2005 城市供排水紫外线消毒设备》中，附录 C 紫外线有效剂量检测方法与附录 D 紫外线平均剂量检测方法。

紫外线设备设计书参考标准《GB/T 19857-2005 城市供排水紫外线消毒设备》中，附录 E，并提供设计书备案。

回流紫外线灭菌槽采用食品级抗 UV 材料。

5.15

水培系统消毒灭菌与清洗规范

水培系统消毒灭菌与清洗规范由种植工艺提出制定，并提供备案。

植物工厂水培系统消毒灭菌与清洗每年不低于 2 次。

水培系统消毒灭菌与清洗后，系统残留量不得影响种植效果。

检验方法参考标准《GB/T 5750 生活饮用水标准检验方法》系列标准的 GB/T 5750.1，GB/T 5750.4，GB/T 5750.6，GB/T 5750.11，GB/T 5750.13。

5.16

营养液调节控制系统要求

营养液的温度 T、pH 值、EC 值需要在营养液供给的进口与出口安装检测设备，测量精度符合本标准第 6.1.1 相关要求。

养液的 pH 值、EC 值、营养液配方使用的各元素含量在线配制与控制的设备，设备设计方需要提供误差与精度指标供种植工艺参考，并提供设计书备案。

在线配制使用的计量泵内部与营养液接触的材料需要符合第 5.11.1 与第 5.11.2 的标准要求。

在线配制使用的电磁阀内部与营养液接触的材料需要符合第 5.11.1 与第 5.11.2 的标准要求。

5.17

水质要求与重金属污染限量要求

5.17.1

生产用水水质要求

首先要符合标准《GB 5749-2006 生活饮用水卫生标准》各项要求。

水质检验符合标准《GB/T 5750.1～13-2006 生活饮用水标准检验方法》要求。

有机基质栽培生产用水最低要求应符合标准《GB 5749-2006 生活饮用水卫生标准》各项要求，或者按照以下要求。

营养液配用的生产用水，可以采用符合标准《GB 5749-2006 生活饮用水卫生标准》的水质进行二次制备，成为生产用水。

制成的生产用水符合表 4 基本要求：

表 4 生产用水常规限值

名称	符号	数值	单位	备注
酸碱值	pH	6±0.5		测量：1atm 和 25℃
溶液中可溶性盐浓度	EC	≤0.25	mS/Cm	测量：25℃
溶解氧	DO	≥5	mg/L	测量：1atm 和 25℃
化学需氧量	COD	≤3	mg/L	可以采用 ppm 计量
生化需氧量	BOD	≤1	mg/L	5 日生化需氧量
浑浊度		≤1	NTU	测量：1atm 和 25℃
氯化钠	NaCl	≤0.05	mg/L	
残留氯气		≤0.3	mg/L	存放 12 hr 后
氟化物		≤1.0	mg/L	
硒		≤0.01	mg/L	
总硬度		100±50	mg/L	以碳酸钙（C_aCo_3）计
总大肠菌群		0	MPN/100mL	可采用 CFU/100mL 单位
耐热大肠菌群		0	MPN/100mL	可采用 CFU/100mL 单位
大肠埃希氏菌		0	MPN/100mL	可采用 CFU/100mL 单位
菌落总数		＜100	CFU/100mL	
总α 放射性体积活度		≤0.5	Bq/L	标准试剂和蒸馏水
笨		≤0.01	mg/L	
六六六（总量）	BHC	≤0.005	mg/L	化学名称：六氯环己烷
滴滴涕	DDT	≤0.01	mg/L	
EC 值	EC	≤0.25	ms/cm	

注：无机盐营养液用水检测 COD，有机营养液用水检测 BOD。

注：水质非常规指标及限值参考标准《GB 5749-2006 生活饮用水卫生标准》表 3。

水培生产用水的化学需要氧量检测符合标准《GB 11914 水质化学需氧量的测定 重铬酸盐法》。

水培生产用水的检测符合标准《GB/T 5750 .1-13 生活饮用水标准检验方法》各项检验方法。

5.17.2

基质与无机盐重金属污染限量要求

栽培基质中，Cd 和 Hg 是主要的重金属污染及潜在生态风险因子，Cr、Cu、Pb、Zn 和 As 的污染能力较小。

栽培基质的重金属污染限量标准，按照本标准 4.1.2 表 1 执行。

检测方法参考标准《GB 15618-2018 土壤环境质量 农用地土壤污染风险管控标准》中第 7.2 项表 4 执行。

无机盐纯度要求：优先采用分析纯，在保证干扰杂质不干扰配比浓度测量下，可以采用化学纯。

无机盐材料供应商需要提供重金属含量测定报告备案。

栽培基质供应商需要提供重金属含量测定报告备案。

5.17.3

生产用水重金属限量要求

生产用水的重金属限量包括生产用水和添加成分，限量值参考表 5。

营养液供应商（包括自行配制）需要提供重金属含量测定报告备案。

表 5 生产用水重金属及其他金属限量值

序号	元素	限量值	单位	适合性
1	镉（Cd）	≤0.003	mg/L	营养液 5.5≤pH≤6.5
2	汞（Hg）	≤0.001	mg/L	
3	砷（As）	≤0.01	mg/L	
4	铅（Pb）	≤0.01	mg/L	
5	铬（Cr）	≤0.05	mg/L	
6	铜（Cu）	≤0.1	mg/L	
7	镍（Ni）	≤0.002	mg/L	
8	锌（Zn）	≤0.2	mg/L	
9	锡（Sn）	≤0.001	mg/L	

本表部分限值部分参考标准《GB 2762-2017 食品安全国家标准 食品中污染物限量》

重金属含量检测参标准《GB/T 5750.6-2006 生活饮用水标准检验方法 金属指标》，检测需要符合表 6 规定的重金属检测标准。

表 6 重金属含量检测标准

序号	元素	参考标准	适合性
1	镉（Cd）	GB/T 7471 水质 镉的测定 双硫腙分光光度法	营养液 5.5≤pH≤6.5
2	汞（Hg）	GB/T 7468 水质 总汞的测定 冷原子吸收分光光度法	
3	砷（As）	GB/T 7485 水质 总砷的测定 二乙基二硫代氨基甲酸银分光光度法	
4	铅（Pb）	GB/T 7475 水质 铜、锌、铅、镉的测定 原子吸收分光光度法	
5	铬（Cr）	GB/T 7467 水质 六价铬的测定 二苯碳酰二肼分光光度法	
6	铜（Cu）	GB/T 7474 水质 铜的测定 二乙基二硫代氨基甲酸钠分光光度法	
7	镍（Ni）	GB/T 11910-1989 水质 镍的测定 丁二酮肟分光光度法	
8	锌（Zn）	GB/T 7472-1987 水质 锌的测定 双硫腙分光光度法	
9	锡（Sn）	GB/T 5750.6-2006 生活饮用水标准检验方法 金属指标	

注：采用与本表不同的其他标准规定的检测方法需要注明。

5.18

失效营养液与污水排放要求

失效营养液属于高盐类液体，如果排放液体达到表 7 限量值，依据标准《GB 18918-2002 城镇污水处理厂污染物排放标准》，属于二级排放，需要自行到当地环保质监部门报备。

表 7 失效营养液限量值

名称	限量值	单位	备注
COD	≥100	mg/L	COD 与 BOD5 单独达到限值
BOD5	≥30	mg/L	COD 与 BOD5 单独达到限值
DO	≤3	mg/L	
悬浮物 SS	≥30		
大肠杆菌	＞1000	个/L	

注：失效营养液判定需要营养液供应商根据种植工艺提出，并提供文件备案。

尽量采用对于失效营养液回收再利用与营养液零排放技术措施。

6 种植工艺

植物工厂的植物种植是在植物工厂构造的人工环境下种植工艺实施过程，植物工厂种植效果是种植工艺的表现，植物工厂大部分设备要求和控制参数都是依据种植工艺提出而设置，种植工艺是植物工厂运行的主体。

不同的植物品种，同一种植物的不同生长阶段，种植工艺都有相应的农艺措施，植物工厂设计是围绕种植工艺进行设计和建设。

植物种植工艺说明书需要备案。

注：本标准不对具体植物品种的种植工艺提出规范，植物工厂设计方需要根据种植品种的农艺要求单独提供种植工艺内容。

6.1

无土栽培规范

植物工厂可以采用无机盐营养液培，有机营养液培，有机基质培，无机基质加营养液培。

6.1.1

无机盐营养液规范

无机盐营养液大量元素符合标准《NY 1107-2010 大量元素水溶肥料》中第 4 项要求。检验方法按照该标准中第 5、6 项要求。

无机盐营养液中量元素符合标准《NY 2266-2012 中量元素水溶肥料》中第 4 项要求。检验方法按照该标准中第 5、6 项要求。

无机盐营养液微量元素符合标准《NY 1428-2010 微量元素水溶肥料》中第 4 项要求。检验方法按照该标准中第 5、6 项要求。

氨基酸需符合标准《NY 1429-2010 含氨基酸水溶肥料》中第 4 项要求。检验方法按照该标准中第 5、6 项要求。

腐植酸符合标准《NY 1106-2010 含腐殖酸水溶肥料》中第 4 项要求。检验方法按照该标准中第 5、6 项要求。

无机盐营养液中重金属限量要求符合标准《NY 1110-2010 水溶肥料 汞、砷、镉、铅、铬的限量要求》中第 4 项表 1 限量要求，实验方法参考第 5、6 项。

配制营养液的生产用水符合本标准第 5.17 项要求。

无机盐营养液的酸碱度要求：pH 范围 5.5～6.5，测量精度±0.1 pH。

无机盐营养液 EC 值范围 2.0-4.5 ms/cm，测量精度±0.1 EC。

无机盐营养液具体 EC 值需要根据具体种植品种进行调整。

无机盐营养液工作液温应保持在 18～22℃范围，测量精度±1 ℃。

无机盐营养液工作中的溶解氧 DO≥5 mg/L，测量精度±0.10 mg/L。

无机盐营养液工作中需要进行紫外线消毒灭菌，参考本标准第 5.14 项。

无机盐营养液需要配套杂质过滤装置，过滤筛孔尺寸需要符合种植工艺要求。

筛孔尺寸范围：990-280μ m（对应泰勒制：16-48 目）。

特殊过滤可参考标准《GB T 6005-2008 试验筛 金属丝编织网、穿孔板和电成型薄板筛孔的基本尺寸》中第 5 项表 2 系列。

筛网材料采用食品级，需要提供 SGS 环保认证。

无机盐营养液有毒物质符合表 8 要求。

表 8 有毒物质限量要求

名称	限量值	单位
笨	≤2.5	mg/L
BHC（六六六）	≤0.02	mg/L
DDT（滴滴涕）	≤0.02	mg/L
氟化物（F）	≤3.0	mg/L
酚	≤1.0	mg/L
大肠杆菌	≤1000	个/L

无机盐营养液配制需要提供符合上述要求的备案资料。

允许根据植物特点的农艺要求进行无机盐营养液配制，不符合上述规范的需要提供详细配制说明，重金属限量要求与实验方法说明，并提供备案资料。

6.1.2

水肥一体化基质栽培规范

栽培基质放置容器采用食品级容器，需要提供 SGS 环保认证。

水溶肥料重金属含量符合标准《NY 1110-2010 水溶肥料 汞、砷、镉、铅、铬的限量要求》要求。

采用有机基质，需要提供成分含量与重金属检测报告备案。

采用无机基质，需要提供成分含量与重金属检测报告备案。

水肥一体化生产用水符合 5.17.1 表 4 要求。

水肥一体化设备的材料符合符合第 5.11.1 与第 5.11.2 的要求。

水肥一体化基质栽培的除菌设备需要提供安全使用说明书。

6.1.3

蔬菜育苗基质规范

以腐熟有机物料及天然矿物为主要成分的蔬菜育苗基质质量符合标准《NY/T 2118-2012 蔬菜育苗基质》各项要求。

采用无机盐营养液育苗容器材料符合第 5.11.1 与第 5.11.2 的要求。

7 生产系统电气安全规范

生产系统电气安全包括植物灯与控制系统、营养液控制、生产用水控制、消毒灭菌控制、潮湿环境中设备的电气部分、接触性电气设备部分等。

植物灯需要完全满足标准《GB 7000.1-2015 灯具 第 1 部分：一般要求与试验》中第 8、10、11 项全部要求。

植物灯、营养液控制、生产用水系统等相关电气部分参考标准《GB/T 3805-2008 特低电压（elv）限值》各项要求。

生产系统的电气用电源必须有绝缘层与地面隔离。

生产系统的电气用电源、电气装置金属部分必须要接地线。

生产系统的电气漏电保护参考标准《DB31/167-2002 漏电保护配电装置》相关要求。

定期进行电气漏电安检工作并做检测记录备案。

8 品质检测

品质检测包括下列内容：

营养成分检测：食品中水分，水分活度、蛋白质及氨基酸、粗脂肪、灰分、总膳食纤维、碳水化合物、总碳水化合物、能量、总脂肪、饱和脂肪、胆固醇、可溶性膳食纤维、总糖、钠、铁、钙、维生素（A、B、C、D、K、B1、B2、B6 等），其它矿物质。

（1）农药残留检测。

（2）硝酸盐含量检测，亚硝酸盐含量检测。

（3）重金属检测。

（4）有害物质检测：甲醛检测，有机氯检测。

（5）嘧霉胺、嘧菌胺、腈菌唑、 嘧菌酯残留量的检测。

（6）微生物、寄生虫检测：细菌总数、大肠菌群、霉菌和酵母菌、大肠杆菌、志贺氏菌、金黄色葡萄球菌、沙门氏菌、多菌灵检测、霉菌、酵母、志贺氏菌、致病菌等。

（7）植物生长调节剂残留限量检测。

品质检测符合《GB 2762-2017 食品安全国家标准 食品中污染物限量》要求。

品质检验报告需要备案。

品质检验参考下列标准：

GB/T 5009.38-2003 蔬菜、水果卫生标准的分析方法

GB 2762-2012 食品中污染物限量

GB 2763-2016 食品安全国家标准 食品中农药大残留限量

GB 19338-2003 蔬菜中硝酸盐限量

GB 5009.22-2016 食品安全国家标准 食品中黄曲霉毒素 B 族和 G 族的测定

GB2763-2014 食品中农药最大残留限量

9 产品包装与运输规范

参考下列标准：

GB 4806.7-2016 食品安全国家标准 食品接触用塑料材料及制品

GB 9685-2016 食品安全国家标准 食品接触材料及制品用添加剂使用标准

NY/T 658-2015 绿色食品 包装通用准则

GB 8868-1988 蔬菜塑料周转箱

NY/T 1056-2006 绿色食品 贮藏运输准则

9.1

产品标签与防伪规范

产品标签：

每一包装上应标明产品名称、产品的标准编号、商标（如有）、生产单位（或企业）名称、详细地址、产地、规格、净含量和包装日期等，标志上的字迹应清晰、完整、准确。

防伪标签：

将卷标利用反光贴纸黏贴产品封口,利用贴纸上的雷射卷标与条形码查询产品并追溯。

10 产品出厂质量保证期

水培蔬菜出厂质量保证期不大于 4 天。

有机基质培出厂质量保证期不大于 5 天。

活体蔬菜出厂质量保证期不大于 10 天。

11 植物工厂第三方确认

植物工厂第三方确认是从合同的技术性、合理性、可实施性进行专家团队的一致确认，目的是保证植物工厂符合建设规范与技术规范的科学性，从技术上保证合同双方的利益，第三方确认是维护植物工厂健康发展的技术性措施。

需要合同双方出具委托书。

植物工厂第三方确认只确认技术与设备的可行性。

对植物工厂设计书内容与条款进行技术性确认。

对植物工厂建设资料备案表进行技术性确认。

植物工厂第三方确认不包括植物工厂的设备质量保证。

植物工厂第三方确认不负责合同的执行性。

专家团队由不少于 7 位专业性强的专家教授组成。

植物工厂第三方确认流程参考本标准管理单位（SZFAA）制定的相关文件。

12 植物工厂建设资料备案表

植物工厂设计方需要提供设计书备案表，备案表参考附录 A。

13 植物工厂设计书内容与条款

植物工厂设计书内容与条款参考附录 B。

附录 A：植物工厂建设资料备案表

序号	备案资料名称	备案日期	备注
1	当地大气以地理环境的环评报告		
2	消防设计审核		
3	种植架设计计算书		
4	种植架稳定性计算书		
5	种植架间自动化操作设备稳定性计算书		
6	植物灯测量报告		
7	灯具电气连接图		
8	无线网络控制系统资料		
9	二氧化碳探头精度与使用寿命说明书		
10	温度、湿度探头精度与使用寿命说明书		
11	管路管件的流量、压强、温度设计计算书		
12	电磁控制阀门电气图		
13	管路管件材料检测报告		
14	种植槽与种植箱材料检测报告		
15	养液储存箱材料检测报告		
16	紫外线回流消毒灭菌设计书		
17	水培系统消毒灭菌与清洗规范		
18	营养液调节控制系统设计书		
19	失效营养液判定文件		
20	植物种植工艺说明书		
21	无机盐营养液配制说明		
22	水肥一体化营养基质说明		
23	品质检验报告		
24	产品重金属限量检测报告		
25	合同授权的植物工厂第三方确认书		
26	植物工厂设计书		

附录 B：植物工厂设计书内容与条款

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种植设备概述

种植工艺概述

总体要求概述

二、植物工厂规划内容

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周边环保要求

给排水要求

供电与安全要求

种植空间自然光条件

室内通风规范要求

室内构件防护与装修的环保要求

通风除尘室设计要求

种植架间距与通道要求

入口隔离防护要求

植物工厂排放要求

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二氧化碳供给与浓度检测要求

氧气浓度与检测要求

空气成分浓度与通风量要求

种植空间消毒与灭菌要求

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合同条款制定第三方确认委托书

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T/SZFAA 03-2019

Specifications for Construction of Artificial Light-Type Plant Factories

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Preface

The production system of the plant factories determines that the vegetables planted are the vegetables with the highest food safety level among all vegetables up to now. This production system is realized by integrating both planting exquipments and techniques involved,so as to ensure that the vegetables planted by the plant factories have excellent vegetable nutrition indexes. We have formulated the construction specifications for construction of artificial light-type plant factories to ensure that all those plant factories can completely conform to this production system.

This standard establishes a set of systematic specifications for artificial light-type plant factories dealing with site selection, plants building, equipment manufacturing, planting technology, safe production, vegetable quality measurement, vegetable packaging and transportation, and product quality guarantee period, The resultant traceability of vegetable food safety and nutritional quality is beneficial to the healthy development of artificial light-type plant factories.

This standard can also be used as a reference for the construction of plant factories with other strict requirements on valuable nutrients, biochemical indexes, heavy metals, pesticide residues, etc.

This standard is proposed by Foshan Haoliang Solid Light Source Research Institute, Peking University Shenzhen Graduate School (Peking University) and Zhongshan Shanzai Agriculture & Forestry Technology Co., Ltd.

This standard was drafted by Shenzhen Facility Agriculture Association, Fujian Sino-Science Biological Co., Ltd., Jiangsu Tangcheng Neon Digital Technology Co., Ltd. (Jiangsu Tangcheng Biological Lighting Co., Ltd.), Shenzhen E Light Farm Eco Technology Co.,Ltd.,Foxconn technology group, Shenzhen Fluence Technology PLC, Xiamen GP. Xiamen Top-Succeed Electronics Technology Co.,Ltd.; Hangzhou Yihao Agricultural Technology Co., Ltd., Shenzhen Haizhuo Biotechnology Co., Ltd., HHH Led lighting Co.,Limited, Shenzhen Ninuo Lighting Industry Co., Ltd. and Jiangmen Liaoshi Lighting Technology Co., Ltd.

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Specifications for Construction of Artificial Light-Type Plant Factories

1 Scope

This standard is used as the construction specifications for Artificial Light-Type Plant Factories and Container-type Plant Factories, and can also be used as part of reference for Hybride Light-Type Plant Factories, Sun Light-Type Plant Factories, Plant Cultivation Cabinets, etc.This standard covers the technical specifications for the site selection, construction, decoration, planting equipment, nutrient solution and substrate, quality measurement, packaging materials, safe production, etc. of Artificial Light-Type Plant Factories. It is a standard document for the construction of Artificial Light-Type Plant Factories. The plants to which this standard applies include the construction specifications for industrial planting of economic crops such as leafy vegetables, melon and fruit vegetables, Chinese herbal medicines, flowers, greenhouse fruit trees, etc.

2 Normative References

The clauses in the following documents are taken as clauses of this standard by reference to this standard. All subsequent amendments (excluding the contents of measurement) or revisions of the referenced documents in the standard year are not applicable to this standard. However, all parties that reach an agreement according to this standard are encouraged to study whether the latest version of these documents can be used or not. The latest version of any reference document without year is applicable to this standard.

General Standards:：

GB/T 1.1-2009 Guidelines for Standardization-Part 1: Structure and Compilation of Standards

T/SZFAA 01-2018 Specification for Spectral Parameters of Plant Artificial Radiation Sources

GB2822-2005 Standard Size

References to other standards are reflected in the articles

Note: Plant Factories need to refer to standards of different technical disciplines. In order to better apply this standard, specific professional standards are quoted in relevant clauses.

3 Terms and Definitions

This standard adopts the following terms and definitions:

3.1

Plant Factory

Plant Factory is an advanced stage of facility agriculture development and a form of industrialized production of agricultural planting. It is the technical application of integrated planting environment automation control, electronic technology, sensor technology, Internet of

Things, biotechnology, robots, new materials, photoelectric devices and other disciplines to realize continuous production of plants on an annual order basis. It adopts computer and Internet of Things to control the production process of plant growth such as illumination, agronomic measures, carbon dioxide concentration, temperature, humidity, ventilation, disinfection and sterilization, and constructs a new agricultural planting method based on science and independent of experience and intuition.

Plant Factories are divided into three types according to the light radiation mode: Artificial Irradiating Plant Factories, Mixed Irradiating Plant Factories, Sun Irradiating Plant Factories.

3.2

Artificial Light-Type Plant Factory

A plant factory that mainly provides light radiation to the growth process of plants with artificially manufactured light sources.

3.3

Hybride Light-Type Plant Factory

A plant factory that provides light radiation to the growth process of plants by superposing the main Ethernet sunlight and artificial light sources.

3.4

Sun Light-Type Plant Factory

A plant factory that mainly provides light radiation to plants during their growth.

3.5

Spectral Quantum Distribution（SQD）

The spectral quantum distribution curve calculated from the spectral power distribution (SPD) of the plant lamp.

3.6

SQD Peak

The maximum value of the photon micromolar of the spectral quantum distribution curve, in unit of：μmol/(λ.s).

3.7

Planting Technology

Agronomic measures applied in the whole process of plant from seed germination to harvest are the production techniques formulated for the planting process.

3.8

Amount of Light Supplied

The minimum value of photon flux density that a plant lamp must provide for a plant planting process, in unit of：μmol/m^2s。

Note: The measured photon flux density (MPFD) of the plant lamp must be greater than the amount of light supplied.

3.9

Planting Matrix

Replacing soil to provide solid medium for supporting and fixing roots, the planting matrix includes inorganic matrix and organic matrix.

3.10

Organic Matrix

Organic matrix is a kind of cultivation medium formed by harmless treatment of non-soil organic materials, or it can be a compound formed by mixing these organic materials with other materials.

3.11

Nutrient Solution

Nutrient solution is to provide water and nutrients needed by plant growth in liquid form, and the nutrient solution includes organic nutrient solution and inorganic salt nutrient solution, or organic-inorganic mixed total nutrient solution.

3.12

Planting Racking

It is composed of bearing members such as pillar pieces, cross beams (or cantilever beams) , used for supporting and fixing a multi-layer racking of planting equipment.

3.13

Third Party Confirmation of Plant Factories

The third-party expert team specified in the contract signed by the Plant Factories shall be entrusted to carry out technical confirmation conforming to standardization and normalization in terms of contract technical terms, technical performance of production equipment, technical feasibility and technical advancement. The third-party confirmation of the Plant Fatories is the final technical confirmation authorized by the contract.

Both parties to the contract are allowed to negotiate for acceptance and confirmation by themselves, which shall be indicated in the contract.

4 Specifications for Construction of Plant Factories

4.1

Site Selection Requirements for Plant Factories

4.1.1 Air Quality Requirements for Site Selection Environment

The concentration limit values of NOx, VOCs, O3, PM2.5, PM10, TSP, Lead, BaP and other concentrations in the ambient air of the Plant Factories site are divided into Area I and Area II according to items 4.2, tables 1 and 2 of GB 3095-2012 ambient air quality standard.

Try to choose the address in Area I.

For the selected address in Area II, the local EIA report shall be obtained and submitted for the record.

If the selected address is in Area II, ventilation equipment needs to add corresponding PM 2.5 filtering equipment.

It is not allowed to locate in the harmful gas discharge area.

PM2.5 filtration quality inspection of filtration equipment shall be carried out in accordance with all provisions of HJ 618-2011 gravimetric method for ambient air PM10 and PM2.5.

All pollutant analysis methods in the EIA report comply with the analysis method requirements of Item 5.3 of GB 3095-2012 Environmental Air Quality Standard, and the data validity meets the requirements of Table 4 of Item 6.

It is allowed to replace the actual measurement with the environmental air assessment report provided by the local government and submit it for the record.

4.1.2 Environmental Quality Requirements for Site Selection

Priority should be given to areas with smooth air, pure water quality, unpolluted soil and good ecological environment. Pollution source areas should be avoided as much as possible.

The water quality for site selection shall be guaranteed, and the site selection shall be made in areas with clean and pollution-free surface water and groundwater. There is no pollution source that poses a pollution threat to the production area in the water area or upstream of the water area. Non-production water meets the requirements of items 4.1.1-4.1.3 in the standard "CJ/T 206-2005 Water Quality Standard for Urban Water Supply". The water quality inspection Project meets the requirements of Table 1 in Item 4.2.1. The water quality inspection frequency meets the measurement frequency requirements in Table 3 in Item 6.7.

Site is not allowed to be selected in areas where toxic ions and dumping of hazardous substances are concentrated.

It is not allowed to select addresses in areas where heavy metal ions such as mercury, cadmium, chromium, lead, arsenic, copper, zinc and fluorine are enriched.

The total amount of heavy metal elements in plant soil and atmospheric dust shall not exceed Table 1.

Table 1 Risk Screening Values of Heavy Metal Pollution in Soil

No.	Elements	RSV （mg/kg）	Compatibility
1	Cadmium	≤0.3	pH value of soil 5.5≤pH≤6.5
2	Mercury	≤1.8	
3	Arsenic	≤40	
4	Lead	≤90	
5	Chromium	≤150	
6	Copper	≤50	
7	Nickel	≤70	
8	Zinc	≤200	

The measurement method is implemented in Table 4 of Item 7.2 of GB 15618-2018 Soil Environmental Quality Agricultural Land Soil Pollution Risk Control Standard.

For the soil pH value that does not meet the requirements of Table 1, refer to Item 4.1.1 of GB 15618-2018 Standard for Risk Control of Agricultural Land Soil Pollution for Soil Environmental Quality.

For Plant Factories with high site selection requirements, please refer to Table 7 of Items 4 and 7.1 of NY/T 391-2013 Environmental Quality of Green Food Producing Areas.

4.2

Requirements for Plant Design and Decoration

The newly designed workshop meets all requirements of the standard GB 50073—2001 Specifications for Design of Clean Workshop.

The renovation of the old plant buildings conforms to the standard "GB 50325-2013 Indoor Environmental Pollution Control for Civil Construction Projects" in Items 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6.

The building materials of the new and old plant buildings shall meet all requirements of the standard GB 6566-2010 Radionuclide Limits for Building Materials.

Relevant requirements of reference standard "GB 50015-2010 Specifications Design of Building Water Supply and Drainage" for plant water supply and drainage.

Relevant requirements of JGJ16－2008 Specifications for Electrical Design of Civil Buildings are implemented for power transmission and distribution in workshops.

The lightning protection design of plant buildings meets the requirements of the standard GB 50057－2011 Specifications for Lightning Protection Design of Buildings.

Item 7 of the Reference Standard for Lighting in Plant Non-production Space "GB 50034－2013 Architectural Lighting Design Standard".

Requirements for Plant Factories Decoration:

All decoration materials conform to CCEL national environmental protection certification.

The decoration materials meet the requirements of items 3.1.2, 3.3.5, 3.4, 3.5 and 3.6 in the standard GB 50325-2013 Indoor Environmental Pollution Control for Civil Construction Projects.

The ground waterproof treatment materials and marking materials in the plant shall conform to CCEL national environmental protection certification.

The ground shall be marked with AREA and PASSAGE.

The area identification symbol should be obviously different from the color of the wall surface and the ground, and the specific color is not limited.

When the plant factory is delivered for use, the total volatile organic compound TVOC in the plant is ≤ 2 mg/m^3

After interior decoration, the harmful substances meet the requirements of Table 1, Item 4 of the Standard DB13/3005-2017 Standard for Limits of Volatile Organic Compounds in Architectural Coatings and Adhesives.

Third-party confirmation of plant factories requiring EIA indicators before delivery of plant buildings.

Equipment installation is not allowed without confirmation of EIA indicators. This provision is mandatory.

4.3

Specifications for Dust-free Workshop Grades

The standards for dust-free workshops established by plant factories shall be implemented in accordance with Table 2, in which there is ISO14644-1 grade correspondence.

The selection of dust-free workshop grade shall be determined according to the plant variety and planting technology of the plant plant, and shall not be lower than 100,000 grade (ISO Class 8).

The inspection reference standard "GB 50073—2001 Specifications for Design of Clean Workshop" requires Appendix C.

Table 2: Requirements for Air Cleanliness, Microorganisms and Sedimentated Bacteria in Dust-free Workshop

Class/ISO14644-1	Maximum Allowable Number of Dust Particles/ m^3 ≥0.5μm Number of dust particles	≥5μm Number of dust particles	Maximum Allowable Number of Microbes Plankton/ m^3	Sedimentated Bacteria /Vessel
Class 100 ISO Class5	≤3500	0	5	1
Class 1000 ISO Class6	≤35000	≤250	100	3
Class 10000 ISO Class7	≤350000	≤2500	500	10
Class 100000 ISO Class8	≤3500000	≤25000	1000	15

Note: If ISO grade is adopted, a description of the quoted items is required.

4.4

Disinfection and Sterilization of Dust-free Workshop

Adhesive sterilization materials are not allowed.

The maximum allowable number of microorganisms and sedimentated bacteria require disinfection and sterilization.

Sterilization equipment shall conform to CCEL national environmental protection certification.

Ultraviolet sterilization is adopted to meet the standard GB 15981-1995 Evaluation Methods and Standards for Disinfection and Sterilization Effect. The second evaluation method and standard for ultraviolet surface disinfection effect are implemented.

Sterilization by ozone shall comply with the following requirements:

Ozone concentration released in air：3-5 ppm.

The ozone amount for disinfection and sterilization of nutrient solution is 2.5-3.5 mg/L .

After sterilization and deodorization of ozone, the concentration of ozone in the air in the workshop is less than 0.1 ppm to meet the working conditions.

Disinfection with liquid disinfectants is in accordance with the third evaluation method and standard of disinfection and sterilization effect of liquid disinfectants in GB 15981-1995.

During disinfection and sterilization in dust-free workshops, vegetable planting (including vegetable storage) and personnel retention in the workshops are strictly prohibited.

4.5

Ventilation Requirements for Plant Factories

The air filtration grade of ventilation equipment shall meet the requirements of Table 2 in 4.3 Dust-free Grade Specification.

Building ventilation requirements conform to item 7.2 of GB 50352-2005 General Principles for Design of Civil Buildings

Ventilation equipment working time requirements:

Ventilation space volume: space volume = plant area × plant height, unit: m^3.

Ventilation volume, unit: m^3/hr.

According to the space volume and ventilation volume, calculate the ventilation time hr according to the following formula:

Hr = k * space volume/ventilation, unit: HR, where: K- displacement coefficient (1-4).

Ventilation working time requirements: ventilation time ≤1.2 hr, allowing multiple ventilation devices to work in parallel.

Ventilation equipment shall meet the following requirements:

Export wind pressure, unit: Pa, export wind pressure ≤150 Pa.

At 1m away from ventilation equipment, equipment noise ≤50 db.

The air inlet in the plant needs to detect the carbon dioxide concentration, temperature and humidity of the air inlet.

The air outlet in the plant needs to detect the carbon dioxide concentration, temperature and humidity of the air.

During ventilation, the average indoor temperature conforms to 6℃ of the nominal temperature of the planting process.

During ventilation, indoor carbon dioxide concentration and humidity are not limited.

The grade of ventilation filter shall be in accordance with Table 3.

Filter Classification	Initial Efficiency	Intermediate Efficiency	High-Intermediate Efficiency	Sub-High Efficiency
Particle Size (μm)	≥5.0	≥1.0		≥0.5
Counting Efficiency （%）	20≤E＜80	20≤E＜70	70≤E＜99	95≤E＜99.9

Note: EN779 and EN1882-1 standards are allowed.

The intake air filter reference standards "GB/T 14295-2008 Air Filter" and "GB T 13554-2008 High Efficiency Particulate Air Filter".

Filter performance test methods refer to GB T 6165-2008 High Efficiency Particulate Air Filter performance test methods efficiency and resistance.

For ventilation with an area of more than 1,000 square meters, air quality pre-treatment room shall be adopted for treatment and then transported into the workshop. The air supply equipment shall refer to GB/T 23174-2008 Exhaust Fan.

The reference standard for indoor air outlet and ventilation equipment is GB/T 23174-2008 Exhaust Fan.

When the ventilation equipment for indoor air outlet and inlet does not work, outdoor air shall not enter the plant building through the ventilation equipment.

4.6

Safety and Fire Fighting

Plant factories shall implement the following standards according to the national fire protection regulations:

Fire Prevention Law of the People's Republic of China, Provisions on Fire Supervision and Inspection.

Comply with the 3rd requirement of the standard GB 50016-2014 Code for Fire Protection Design of Buildings.

The construction unit needs to apply to the fire control institutions of the public security organs for fire control design review, and apply to the fire control institutions of the public security organs for fire control acceptance after the completion of the construction project.

The Plant Factories can only carry out the third-party confirmation after providing the acceptance documents of the local public security fire department.

5 Equipment Specifications

Equipment specifications are the basic requirements for plant Plant Factories construction equipment, and the specific equipment selection needs to be formulated according to the Plant Factories planting technology.

5.1

Design Requirements of Planting Racking

The height, width, height and arrangement of the planting racking design must first meet the requirements of planting technology.

The overall strength, stability analysis and bearing capacity of the planting racking need to be filed with the design calculation sheet.

The maximum beam length of the planting racking is ≤ 3 m.

5.1.1

The height of the planting racking is more than ＞4 m, and the unit load is less than or equal to ≤1500 Kg. Refer to the following standards:

According to the standard "GB/T 28576-2012 Industrial Shelf Design Calculation", the drive-in racking in item 4.1.2 and the ordinary pallet racking in item 4.3 are designed.

The height of the planting racking is more than ＞10 m, and the unit load is more than or equal to ≥400 Kg, so the finite element overall analysis report shall be provided, and the stability check calculation is not required for providing the finite element analysis report.

The thin-walled cold-formed steel members meet the requirements of the standard GB 50018-2002 Technical Specification for Thin-walled Cold-formed Steel Structures.

Planting racking: when the height/width is ≥7, gantry beams need to be added between planting rackings, stability checking calculation needs to be carried out, and a planting racking stability calculation sheet is provided for filing.

For stability check calculation reference, the 9th requirement of the standard "GB/T 28576-2012 Industrial Shelf Design Calculation" meets the requirements of Items 5.3, 5.5 and 10.1.6 of the "GB 50018-2002 Technical Specification for Cold-Formed Thin-Walled Steel Structures".

The stability coefficient refers to items A.1.1-2 and A.2 in table a of appendix a.

Deformation requirements for cross beam of each layer of planting racking: central deflection h≤4.5 mm/m within 8 years.

The R series in GB2822-2005 Standard Size is preferred for the size of the planting rack.

It is not allowed to use nonmetallic materials to make the planting racking.

5.1.2

The height of the planting racking is ≤4 m, and the unit load is ≤900 Kg. Refer to the following standards:

According to item 4.1 of the standard SB/T 10166-1993 Metal Light Combined Shelf, the two-column supported combined racking and the four-column supported combined racking are designed.

The product specification series and size requirements conform to Table 1 of Item 4.3 of SB/T 10166-1993 Metal Light Combined Racking.

The assembly quality meets the requirements of Item 5.6 of SB/T 10166-1993 Metal Light Combined Racking, and the dimensional tolerance meets the requirements of Table 3 of Item 5.6.2.3.

The thin-walled cold-formed steel members meet the requirements of the standard GB 50018-2002 Technical Specification for Cold-formed Thin-walled Steel Structures.

Planting racking: when the height/width is ≥7, gantry beams will be added between the planting racks, and the stability calculation sheet of the planting racking will be provided for filing.

For stability check calculation reference, the 9th requirement of the standard "GB/T 28576-2012 Industrial Racking Design Calculation" meets the requirements of Items 5.3, 5.5 and 10.1.6 of the "GB 50018-2002 Technical Specification for Thin-Walled Cold-Formed Steel Structures".

The stability coefficient refers to items A.1.1-2 and A.2 in table a of appendix A.

Deformation requirements for cross beam of each layer of planting racking: central deflection h≤4.5 mm/m within 8 years.

The design dimensions of the planting racking conform to the R series in the standard GB2822-2005 Standard Dimensions.

It is allowed to use nonmetallic materials to manufacture the planting rack, which shall meet the relevant requirements of 5.1.2.

5.2

Anti-corrosion of Planting Racking

The primer and topcoat materials of anticorrosive paint conform to CCEL national environmental protection certification.

It meets the requirements of Item 11.2 of GB 50018-2002 Technical Specifications for Thin-Walled Cold-Formed Steel Structures.

Table D.0.2 in Appendix D of GB 50018-2002 Technical Specifications for Thin-Walled Cold-Formed Steel Structures refers to the service life of primer and topcoat of anticorrosive coatings.

5.3

VOC (Volatile Organic Compound) in Protective Coating of Planting Racking

Rust-proof paint for planting rack shall conform to CCEL national environmental protection certification requirements.

When the plant plant is delivered for use, the total volatile organic compound TVOC in the center of the planting racking is ≤ 0.8 mg/m3.

Refer to Table 1 of Item 4 of DB13/3005-2017 Standard for Limits of Volatile Organic Compounds in Architectural Coatings and Adhesives for specific limits.

Note: As volatile organic compound VOC(Volatile Organic Compound) can participate in atmospheric photochemical reaction under certain conditions, other pollution problems will occur.

5.4

Safety Inspection of Planting Racking

Comply with the requirements of clauses 6.1-6.2.3.2 in GB/T 33454-2016 Storage Racking Usage Specification.

After the plant plant is completed, it will be inspected every 6 months, and key inspection items will be added when necessary.

5.5

Ventilation for Each Floor of the Planting Racking

Ventilation for each floor of the planting racking is not necessary, but needs to be set according to the requirements of planting technology.

If ventilation is required, the following requirements shall be met:

Wind speed control range of each layer of the planting racking: 0.5-4 m/min.

The noise of ventilation fan on each floor of the planting racking is ≤15 db (at the air outlet 0.2 m).

5.6

Plane Layout and Main Passage of Planting Racking

The plane layout of the planting racking shall meet the requirements of smooth ventilation and convenient operation of the plant plant, and the working channel and main channel between the planting rackings shall conform to the principle of safe operation.

The distance between the planting frame and the building wall is more than or equal to ≥0.5 m in order to prevent migratory bacteria.

For box-type plant factories composed of metal structural parts, effective protective measures are taken against migratory bacteria. Allow the planting frame to be arranged close to the wall surface of the box body.

The spacing between the planting rackings shall be designed in proportion to the width of the planting rackings, based on the principle of convenient operation, but not less than 0.6 m.

Requirements for main passage: shall not be lower than the minimum width required for transportation equipment.

The ground of the main passage needs to be marked, and the color is not limited.

5.7

Equipment Requirements for Automatic Operation between Planting Rackings

The distance between the two sides of non-rail equipment and the planting rack shall not be less than 0.3 m.

The distance between the two sides of track equipment and the planting frame shall not be less than 0.2 m.

When the height/width of the automatic operation equipment is ≥3, the stability calculation sheet of the equipment shall be provided for filing.

5.8

Lamps for Planting Rackings

The lamp meets the requirements of the standard "T/SZFAA 01-2018 Spectral Parameters Specifications for Plant Artificial Radiation Sources".

The test report meets the requirements of Appendix A to the "Specifications for Spectral Parameters of Plant Artificial Radiation Sources by T/SZFAA 01-2018".

The light source spectrum meets the spectral requirements of planting technology.

Plant light spectrum parameters must meet the supply requirements of planting technology.

The SQD peak shift of the 10000 hr light source is ≤3 nm.

PPF attenuation of 10000 hr light source ≤10%.

The initial value for calculating PPF attenuation is the light supply required by the spectral parameters of the planting process.

Air cooling and water cooling are not recommended for multi-storey plant lamp.

Air cooling and water cooling are allowed in mixed light plant factories.

Artificial light plant plant lamp IP shall not be lower than IP53.

The IP of mixed light plant plant plant lamp shall not be less than IP65.

The lamp enclosure protection and IP code reference standard "GBT 4208-2017 Enclosure Protection Level (IP Code)", the general requirements for lamp enclosure protection conform to the requirements of Article 11-15.

It is necessary to provide the electrical connection diagram of lamps for the record.

Lamps and lanterns materials conform to CCEL national environmental protection certification requirements.

The safety performance of lamps shall comply with relevant requirements of GB 7000.1-2015 Lamps Part 1: General Requirements and Tests.

The electrical performance of lamps shall comply with the relevant requirements of the standard GB 17625.1 Electromagnetic Compatibility Limits Harmonic Current Emission Limits (Input Current for Each Phase of Equipment ≤16A).

The electromagnetic performance of lamps shall comply with relevant requirements of GB 17625.2-11 Electromagnetic Compatibility Test and Measurement Technology.

For plant lamps controlled by wireless network, system data shall be submitted for filing.

5.9

Concentration Control of CO2

The average CO2 concentration control capability of plant factories ranges from 600 ppm to 1800 ppm.

The specific carbon dioxide concentration control amount is determined by the planting process.

Equipment generating carbon dioxide from chemical reaction shall not be placed in the plant building, and carbon dioxide gas shall be transported by pipeline.

The carbon dioxide concentration measurement probe shall not be less than one probe per 20 m2, with measurement accuracy ≤ 5%, and the measurement sensor shall be calibrated regularly.

The accuracy and service life of carbon dioxide probe need to provide parameter filing, which is the production accident analysis filing.

When working on site, the concentration of carbon dioxide is ≤2000 ppm, which is mandatory.

5.10

Temperature and Humidity Control

The temperature control capability in the production room of the plant plant is within the range of 18-30℃.

The relative humidity control capability in the production room of the plant plant is within the range of RH: 50-90%.

The specific temperature and humidity values are controlled according to the parameters proposed by the planting process.

The temperature measurement probe shall not be less than one every 30 m2, and the measurement accuracy shall be ≤ 1℃, and the measurement sensor shall be calibrated regularly.

Humidity measurement probes shall not be less than one probe per 50 m2, with measurement accuracy ≤ 4% RH, and measurement sensors shall be calibrated regularly.

The accuracy and service life of temperature and humidity probes need to be provided with parameter filing, which is the production accident analysis filing.

Calculation of energy efficiency ratio of air conditioning, including EER and COP.

Refrigeration energy efficiency ratio (EER)= refrigerating capacity (W)/ refrigerating power consumption (W).

Heating energy efficiency ratio (COP)= heating amount (W)/ heating power consumption (W).

It is required that the energy efficiency grade of air conditioning equipment is ≥3.

Reference standards for energy efficiency grades are GB 12021.3-2010 Energy Efficiency Limits and Energy Efficiency Grades for Room Air Conditioners and GB 21455-2013 Energy Efficiency Limits and Energy Efficiency Grades for Speed Controllable Room Air Conditioners.

5.11

Requirements for Pipe Fittings

Pipeline fittings for production need to provide design calculation sheets for flow rate, pressure and temperature resistance for filing.

Provide pipe fitting layout drawings for filing.

The inlet and outlet of production pipelines need to be controlled by stop valves.

Trench fittings shall not be used except for blowdown.

The use of electromagnetic control valves requires the provision of electrical drawings for the record.

Raw materials used for production pipeline fittings shall meet the requirements of food grade, and sanitary grade may be adopted for special requirements.

The materials of the contact parts of metal valves for production with water or nutrient solution shall meet the requirements of food grade, and sanitary grade may be adopted for special requirements.

Inspection reports shall be provided for the materials made of pipe fittings for production.

5.11.1

Applicable Standards for Materials

The materials meet the following national standards:

Meet the requirements of paragraphs 3.1 and 3.2 of GB 4806.1-2016 National Food Safety Standard General Safety Requirements for Food Contact Materials and Products.

Meet the requirements of the standard GB 4806.7-2016 National Food Safety Standard Plastic Materials and Products for Food Contact.

Meet the requirements of various indexes in Tables 1, 2 and 3 of the standard GB 4806.9-2016 National Food Safety Standard Metal Materials and Products for Food Contact.

5.11.2

Execution Standard of Migration Test

Comply with the requirements of the standard GB 5009.156-2016 General Principles of Soaking Test Methods for Food Packaging Materials and Their Products.

Meet the requirements of the standard GB 31604.1-2015 General Rules for Migration Tests of Food Contact Materials and Products.

Comply with the requirements of the standard GB 31604.9-2016 National Food Safety Standard, Determination of Heavy Metals in Food Contact Materials and Products and Food Simulants.

5.12

Material Requirements for Planting Grooves (Tubes) and Planting Boxes

This material requirement includes planting basket, planting board, planting cotton, etc.

The longest dimension of the planting groove (tube) and the planting box has a central deflection h≤0.004× maximum dimension within 3 years, in mm.

Materials such as planting troughs (pipes), planting boxes, planting baskets, planting plates, planting cotton, etc. shall conform to CCEL national environmental protection certification requirements.

The materials and experiments made of hydroponic planting troughs and boxes shall meet the requirements of 5.11.1 and 5.11.2.

The above-mentioned materials need to be provided with test reports for filing.

5.13

Requirements for Nutrient Solution Storage Tanks

Volume of planting liquid = working volume of planting tank (box)+volume of conveying pipeline.

The volume of nutrient solution storage tank ≥1.5× the volume of planting solution.

The hydroponic nutrient solution storage tank needs to be equipped with a visual liquid level meter and a liquid level sensor.

The hydroponic nutrient solution storage tank needs to meet the requirements of manual cleanability.

The hydroponic nutrient solution storage tank shall not be placed in an environment without disinfection and sterilization.

Nutrient solution pumping and discharging equipment shall not be placed in the storage box.

The materials and experiments of hydroponic nutrient solution storage tank shall meet the requirements of paragraphs 5.11.1 and 5.11.2.

The materials made from the hydroponic nutrient solution storage box need to provide test reports for the record.

5.14

Reflux Ultraviolet Sterilization of Inorganic Salt Nutrient Solution

The ultraviolet peak wavelength is between 250 nm and 270 nm, and the standard peak wavelength is 253.7 nm.

Ultraviolet light is evenly distributed at 0.1-0.2 m above the liquid level, and the liquid level height is less than 0.15 m.

Effective dose of liquid surface ultraviolet ray (measured when the lamp tube is free of scale) ≥70 mJ/cm2.

Time for liquid to pass through ultraviolet radiation area (s): $3 \leq s \leq 10$.

The ultraviolet lamp is ozone-free, which will generate a small amount of ozone in actual use. It should meet the requirement of ozone production ≤1mg/hr, and ventilation equipment can be set separately.

The suitable temperature range for ultraviolet disinfection is 20-40℃.

The amount of ultraviolet radiation is lower than 70% of the initial value and should be replaced in time. The limit is that the surface of the lamp tube does not contain scale.

The ultraviolet lamp tube shall periodically eliminate scale.

In the reference standard GB/T 19857-2005 Ultraviolet Disinfection Equipment for Urban Water Supply and Drainage, Appendix C Ultraviolet Effective Dose measurement Method and Appendix D Ultraviolet Average Dose measurement Method are used for ultraviolet disinfection measurement methods.

The design document of ultraviolet equipment refers to appendix e of GB/T 19857-2005 ultraviolet disinfection equipment for urban water supply and drainage, and provides the design document for the record.

Reflux UV sterilization tank adopts food-grade UV resistant materials.

5.15

Specification for Disinfection, Sterilization and Cleaning of hydroponic systems

Standards for disinfection, sterilization and cleaning of hydroponics systems shall be formulated by the planting technology and filed.

Disinfection, sterilization and cleaning of hydroponics systems in plant factories shall not be less than 2 times a year.

After disinfection, sterilization and cleaning of the hydroponic system, the residual amount of the system shall not affect the planting effect.

Inspection methods refer to GB/T 5750.1, GB/T 5750.4, GB/T 5750.6, GB/T 5750.11, GB/T 5750.13 of the series standards of GB/t5750 standard inspection methods for drinking water.

5.16

Requirements for Nutrient Solution Regulation and Control System

The temperature T, pH value and EC value of nutrient solution need to be equipped with measurement equipment at the inlet and outlet of nutrient solution supply, and the measurement accuracy meets the relevant requirements of Article 6.1.1 of this standard.

For the equipment for on-line preparation and control of pH value, EC value of nutrient solution and content of each element used in nutrient solution formula, the equipment designer shall provide error and precision indexes for reference of planting technology and design documents for filing.

The materials in contact with nutrient solution inside metering pumps used for online preparation shall meet the requirements of standards 5.11.1 and 5.11.2.

The materials in contact with nutrient solution inside the solenoid valve used for on-line preparation shall meet the standard requirements of clauses 5.11.1 and 5.11.2.

5.17

Requirements for Water Quality and Heavy Metal Pollution Limit

5.17.1

Water Quality Requirements for Production Water

It must meet the requirements of the standard GB 5749-2006 Sanitary Standard for Drinking Water.

Water quality inspection meets the requirements of the standard GB/T 5750.1 ~ 13-2006 Standard Test Method for Drinking Water.

The minimum requirements for water for organic substrate cultivation and production shall conform to the requirements of the standard GB 5749-2006 Sanitary Standard for Drinking Water, or the following requirements.

The production water for nutrient solution can be prepared by secondary preparation according to the standard "GB 5749-2006 Sanitary Standard for Drinking Water" to become the production water.

The produced water meets the basic requirements (Table 4):

Table 4 General Limits of Production Water

Name	Symbol	Numeric	Unit	Remarks
Ph Value	pH	6±0.5		Measurement：1atm and 25℃
Soluble Salt Concentration in Solution	EC	≤0.25	mS/Cm	Measurement：25℃
Dissolved Oxygen	DO	≥5	mg/L	Measurement：1atm and 25℃
Chemical Oxygen Demand	COD	≤3	mg/L	ppm metering can be used
Biochemical Oxygen Demand	BOD	≤1	mg/L	Biochemical oxygen demand for 5 days
Turbidity		≤1	NTU	Measurement：1atm and 25℃
Sodium Chloride	NaCl	≤0.05	mg/L	

Residual Chlorine		≤0.3	mg/L	After storage for 12 hours
Fluoride		≤1.0	mg/L	
Selenium		≤0.01	mg/L	
Total Hardness		100±50	mg/L	Based on calcium carbonate (CaCo3)
Total Coliform Group		0	MPN/100mL	CFU/100mL unit can be used
Thermostolerant Coliform Group		0	MPN/100mL	CFU/100mL unit can be used
Escherichia Coli		0	MPN/100mL	CFU/100mL unit can be used
Total Number of Colonies		＜100	CFU/100mL	
Volume Activity of Total α Radioactivity		≤0.5	Bq/L	Standard reagent and distilled water
Benzene		≤0.01	mg/L	
Hexachlorocyclohexane (Total)	BHC	≤0.005	mg/L	Chemical name: hexachlorocyclohexane
Dichloro Diphenyl Trichloroethane	DDT	≤0.01	mg/L	
EC Value	EC	≤0.25	ms/cm	

Note: Inorganic salt nutrient solution uses water to detect COD, while organic nutrient solution uses water to detect BOD.

Note: Reference Standard for Unconventional Indicators and Limits of Water Quality "GB 5749-2006 Sanitary Standard for Drinking Water" Table 3.

The determination of chemical oxygen demand for water for hydroponic production conforms to the standard GB 11914 Water Quality Determination of Chemical Oxygen Demand Dichromate Method.

The measurement of water for hydroponics production conforms to the standard "GB/T 5750 .1-13 Standard Test Methods for Drinking Water".

5.17.2

Requirements for Pollution Limits of Heavy Metals in Substrates and Inorganic Salts

Cd and Hg are the main heavy metal pollution and potential ecological risk factors in the cultivation substrate, while Cr, Cu, Pb, Zn and As have less pollution capacity.

The heavy metal pollution limit standard for cultivation substrates shall be implemented in accordance with Table 1 of 4.1.2 of this standard.

The measurement method is implemented in Table 4 of Item 7.2 of GB 15618-2018 Soil Environmental Quality Agricultural Land Soil Pollution Risk Control Standard.

Purity requirements of inorganic salts: analytical purity is preferred, and chemical purity can be used under the condition that the interfering impurities do not interfere with the Measurement of proportioning concentration.

Inorganic salt material suppliers need to provide heavy metal content determination reports for the record.

The supplier of the cultivation substrate needs to provide the heavy metal content determination report for the record.

5.17.3

Requirements for Heavy Metals Limit in Production Water

The heavy metal limit of production water includes production water and added components is referred to Table 5.

Nutrient solution suppliers (including self-made ones) need to provide heavy metal content determination reports for the record.

Table 5 Limited Values of Heavy Metals and Other Metals in Production Water

No.	Elements	Limit Value	Unit	Compatibility
1	Cadmium（Cd）	≤0.003	mg/L	Nutrient solution 5.5≤pH≤6.5
2	Hydrargyrum（Hg）	≤0.001	mg/L	
3	Arsenic（As）	≤0.01	mg/L	
4	Plumbum（Pb）	≤0.01	mg/L	
5	Chromium（Cr）	≤0.05	mg/L	
6	Copper（Cu）	≤0.1	mg/L	
7	Nickel（Ni）	≤0.002	mg/L	
8	Zinc（Zn）	≤0.2	mg/L	
9	Stannum（Sn）	≤0.001	mg/L	

Part of the limit values in this table is referred to the standard GB 2762-2017 National Food Safety Standard-Limits of Pollutants in Foods

The heavy metal content measurement reference standard "GB/T 5750.6-2006 Standard Test Methods for Drinking Water Metal Indicators" requires that the measurement conform to the heavy metal measurement standards specified in Table 6.

Table 6 Measurement Standards for Heavy Metal Content

No.	Elements	Reference Standard	Compatibility
1	Cadmium（Cd）	GB/T 7471 Water quality-Determination of plumbum-Spectrophotometric method with dithizonc	Nutrient solution 5.5≤pH≤6.5
2	Hydrargyrum（Hg）	GB/T 7468 Water quality-Determination of total hydrargyru- Cold atomic absorption spectrophotometer	
3	Arsenic（As）	GB/T 7485 Water quality- -Determination of total arsenic Sodium diethyldithioc abamate spectrophotometric met hod	
4	Plumbum（Pb）	GB/T 7475 Water quality-Determination of copper, zinc, plumbum and cadmium- Atomic absorption spectrophotometer	
5	Chromium（Cr）	GB/T 7467 Water quality-Determination of hexavalent chromium-Diphenylcarbazide spectrophotometric method	
6	Copper（Cu）	GB/T 7474 Water quality-Determination of copper-Sodium diethyldithiocarbamate spectrophotometric method	
7	Nickel（Ni）	GB/T 11910-1989 Water quality-Determination of nickel-Dimethylglyoxime spectrophotometric method	
8	Zinc（Zn）	GB/T 7472-1987 Water quality-Determination of zinc-Spectrophotometric method with dithizonc	
9	Stannum（Sn）	GB/T 5750.6-2006 Standard Test Methods for Drinking Water-Metallic Indicators	

Note: The testing methods specified in other standards different from this table need to be noted.

5.18

Requirements for Waste Nutrient Solution and Sewage Discharge

The waste nutrient solution belongs to high-salt liquid. If the discharged liquid reaches the limit value in Table 7, it belongs to secondary discharge according to the standard GB 18918-2002 Emission Standard for Pollutants from Urban Sewage Treatment Plants and needs to report to the local environmental protection quality supervision department.

Table 7 Limited Value of Waste Nutrient Solution

Name	Limit Value	Unit	Remarks
COD	≥100	mg/L	COD and BOD5 reach the limit value separately
BOD5	≥30	mg/L	COD and BOD5 reach the limit value separately
DO	≤3	mg/L	
Suspended Solids SS	≥30		
Escherichia coli	＞1000	pc/L	

Note: The determination of waste nutrient solution requires the nutrient solution supplier to propose according to the planting technology and provide documents for filing.

Technical measures for recovery and reuse of waste nutrient solution and zero discharge of nutrient solution shall be adopted as far as possible.

6 Planting Technology

The plant planting in the plant factories is the implementation process of the planting technology under the artificial environment constructed by the plant factories. The planting effect of the plant plant is the performance of the planting technology. Most equipment requirements and control parameters of the plant factories are set according to the planting technology. The planting technology is the main body of the plant factory operation.

Different plant varieties and different growth stages of the same plant have corresponding agronomic measures for the planting technology. The plant factory design is designed and built around the planting technology.

Planting process instructions need to be filed.

Note: This standard does not specify the planting techniques for specific plant varieties. The plant factory designer shall provide the planting techniques separately according to the agronomic requirements of the planted varieties.

6.1

Specification for Soilless Culture

Plant factories can adopt inorganic salt nutrient solution culture, organic nutrient solution culture, organic substrate culture, inorganic substrate and nutrient solution culture.

6.1.1

Specifications for inorganic salt nutrient solution

A large number of elements in the inorganic salt nutrient solution meet the requirements of item 4 in the standard NY 1107-2010 Water Soluble Fertilizer for Large Elements. The inspection method is in accordance with the requirements of items 5 and 6 in this standard.

The content elements in inorganic salt nutrient solution meet the requirements of item 4 of the standard NY 2266-2012 Medium Content Element Water Soluble Fertilizer. The inspection method is in accordance with the requirements of items 5 and 6 in this standard.

Trace elements in inorganic salt nutrient solution meet the requirements of item 4 in the standard "NY 1428-2010 Trace Element Water Soluble Fertilizer". The inspection method is in accordance with the requirements of items 5 and 6 in this standard.

Amino acids shall meet the requirements of Item 4 of the Standard NY 1429-2010 Water Soluble Fertilizer Containing Amino Acids. The inspection method is in accordance with the requirements of items 5 and 6 in this standard.

Humic acid meets the 4th requirement of the standard "NY 1106-2010 Water Soluble Fertilizer Containing Humic Acid". The inspection method is in accordance with the requirements of items 5 and 6 in this standard.

The limit requirements for heavy metals in inorganic salt nutrient solution conform to the limit requirements in Table 1 of Item 4 of the Standard Requirements for Limit of Mercury, Arsenic, Cadmium, Lead and Chromium for Water Soluble Fertilizers NY 1110-2010. For experimental methods, refer to Items 5 and 6.

The production water for preparing nutrient solution meets the requirements of item 5.17 of this standard.

Requirements for pH value of inorganic salt nutrient solution: pH range is 5.5 ~ 6.5, Measurement accuracy is ±0.1 pH

The EC value of inorganic salt nutrient solution ranges from 2.0 to 4.5 ms/cm, and the Measurement accuracy is ±0.1 EC.

The specific EC value of inorganic salt nutrient solution needs to be adjusted according to specific planting varieties.

The working liquid temperature of inorganic salt nutrient solution should be kept in the range of 18 ~ 22℃, and the Measurement accuracy should be ±1℃.

DO of dissolved oxygen in inorganic salt nutrient solution is ⩾ 5 mg/L, and the Measurement accuracy is ±0.10 mg/L.

The inorganic salt nutrient solution requires ultraviolet disinfection and sterilization, refer to item 5.14 of this standard.

Inorganic salt nutrient solution needs to be matched with impurity filtering device, and the size of filtering sieve holes needs to meet the requirements of planting technology.

Sieve size range: 990-280μm（Corresponding to Taylor system: 16-48）。

For special filtration, please refer to table 2 series of item 5 in the standard GB T 6005-2008 basic dimensions of mesh of test screen wire woven mesh, perforated plate and electroformed sheet.

Screen materials are food grade and SGS environmental protection certification is required.

Inorganic salt nutrient solution toxic substances meet the requirements of Table 8.

Table 8 Requirements for Limit of Toxic Substances

Name	Limit value	Unit
Benzene	≤2.5	mg/L
BHC（benzene hexachloride）	≤0.02	mg/L
DDT（Dichloro-Diphenyl-Tricgloroethane）	≤0.02	mg/L
Fluoride（F）	≤3.0	mg/L
Hydroxybenzene	≤1.0	mg/L
Escherichia coli	≤1000	pc/L

The preparation of inorganic salt nutrient solution needs to provide filing materials meeting the above requirements.

It is allowed to prepare inorganic salt nutrient solution according to the agronomic requirements of plant characteristics. Detailed preparation instructions, heavy metal limit requirements and experimental methods shall be provided if it does not conform to the above specifications, and filing materials shall be provided.

6.1.2

Specifications for Substrate Cultivation with Integration of Water and Fertilizer

Food-grade containers are used for placing cultivation substrates, and SGS environmental protection certification is required.

The content of heavy metals in water-soluble fertilizers meets the requirements of the standard NY 1110-2010 limit requirements for mercury, arsenic, cadmium, lead and chromium in water-soluble fertilizers.

With organic matrix, it is necessary to provide component content and heavy metal measurement report for filing.

With inorganic matrix, it is necessary to provide component content and heavy metal measurement report for filing.

Water for integrated water and fertilizer production meets the requirements in Table 4 of 5.17.1.

The materials of water and fertilizer integration equipment meet the requirements of paragraphs 5.11.1 and 5.11.2.

Sterilization equipment for water and fertilizer integration substrate cultivation needs to provide safe operation instructions.

6.1.3

Specifications for Vegetable Substrate

The quality of vegetable substrate with decomposed organic materials and natural minerals as the main components meets the requirements of the standard NY/T 2118-2012 Vegetable Substrate.

Using inorganic salt nutrient solution as seedling container material meets the requirements of 5.11.1 and 5.11.2.

7 Specifications for Electrical Safety of Production Systems

Electrical safety of production system includes plant lamp and control system, nutrient solution control, production water control, disinfection and sterilization control, electrical parts of equipment in humid environment, contact electrical equipment, etc.

Plant lamps need to fully meet all requirements of items 8, 10 and 11 in the standard GB 7000.1-2015 Lamps Part 1: General Requirements and Tests.

Relevant electrical parts such as plant lamps, nutrient solution control, production water system, etc. refer to the requirements of GB/T 3805-2008 Extremely Low Voltage (elv) Limits.

The electrical power supply of the production system must be insulated from the ground by an insulating layer.

Electrical power supply and metal parts of electrical devices of production system must be grounded.

Relevant requirements of "DB31/167-2002 Electric Leakage Protection and Distribution Equipment" as the reference standard for electric leakage protection of production systems.

Regularly carry out electrical leakage safety inspection and make inspection records for the record.

8 Quality Dectection

Quality measurement includes:

Nutritional component measurement: water content, water activity, protein and amino acids, crude fat, ash, total dietary fiber, carbohydrate, total carbohydrate, energy, total fat, saturated fat, cholesterol, soluble dietary fiber, total sugar, sodium, iron, calcium, vitamins (A, B, C, D, K, B1, B2, B6, etc.), and other minerals in food.

(1) Pesticide residue measurement.

(2) Nitrate content measurement, nitrite content measurement.

(3) Heavy metal measurement.

(4) Measurement of harmful substances: formaldehyde measurement and organochlorine measurement.

(5) Determination of pyrimethanil, mepanipyrim, myclobutanil and azoxystrobin residues.

（6）Microorganism and parasite measurement: total number of bacteria, coliform group, mold and yeast, escherichia coli, shigella, staphylococcus aureus, salmonella, carbendazim measurement, mold, yeast, pathogenic bacteria, etc.

（7）Measurement of residue limit of plant growth regulator.

The quality measurement meets the requirements of "GB 2762-2017 National Food Safety Standard-Limit of Pollutants in Food".

The quality measurement report needs to be filed.

Quality measurement refers to the following standards:

GB/T 5009.38-2003 Method for Analysis of Sanitary Standards for Vegetables and Fruits

GB 2762-2012 Limit of Pollutants in Food

GB 2763-2016 National Food Safety Standard Large Residue Limits of Pesticides in Foods

Limit of nitrate in vegetables

GB 5009.22-2016 Determination of Aflatoxin Groups B and G in National Food Safety Standards

GB2763-2014 Maximum Residue Limits of Pesticides in Food

9 Specifications for Product Packaging and Transportation

Refer to the following standards:

GB 4806.7-2016 National Food Safety Standard Plastic Materials and Products for Food Contact

GB 9685-2016 National Food Safety Standard Use Standard of Additives for Food Contact Materials and Products

NY/T 658-2015 General Guidelines for Green Food Packaging

GB 8868-1988 Vegetable Plastic Turnover Box

NY/T 1056-2006 Green Food Storage and Transportation Guidelines

9.1

Product Labeling and Anti-counterfeiting Specifications

Product label:

The name of the product, the standard number of the product, the trademark (if any), the name of the production unit (or enterprise), the detailed address, the place of origin, the specifications, the net content and the packaging date shall be marked on each package, and the handwriting on the mark shall be clear, complete and accurate.

Security label:

Sticking the label with a reflective sticker to seal the product, using the laser label and bar code on the sticker to query the product and trace it back.

10 Quality Guarantee Period

The quality guarantee period of hydroponic vegetables shall not exceed 4 days.

The quality guarantee period for organic substrate cultivation shall not exceed 5 days.

The quality guarantee period of living vegetables shall not exceed 10 days.

11 Third-Party Confirmation of Plant factories

The third-party confirmation of the plant factories is the unanimous confirmation of the expert team from the technicality, rationality and enforceability of the contract. The purpose is to ensure that the plant factories conform to the scientific nature of the construction specifications and technical specifications and technically guarantees the interests of both parties to the contract. The third-party confirmation is a technical measure to maintain the healthy development of the plant factories.

Both parties to the contract are required to issue a power of attorney.

The third party of the plant factories confirms that it only confirms the feasibility of technology and equipment.

Technical confirmation of the contents and terms of the plant factories design document.

Technical confirmation of plant factories construction data filing form.

The third party of the plant factories confirms that the equipment quality assurance of the plant plant is not included.

The third party of the plant factories confirms that it is not responsible for the execution of the contract.

The expert team consists of not less than 7 highly specialized experts and professors.

The third-party confirmation process of plant factories refers to the relevant documents formulated by this standard management unit (SZFAA).

12 Record Form of Plant Plant Construction Data

The designer of the plant factories needs to provide a design document filing form. For the filing form, refer to Appendix A.

13 Contents and Terms of Plant Plant Design

Please refer to Appendix B for the contents and terms of the plant design document.

Appendix A: Record Form of Plant Factory Construction Data

No.	Name of Record Materials	Date	Remarks
1	Environmental Impact Assessment Report on Geographical Environment of Local Atmosphere		
2	Fire Protection Design Review		
3	Design Calculation of Planting Racking		
4	Stability Calculation of Planting Racking		
5	Stability Calculation of Automatic Operation Equipment between Planting Rackings		
6	Plant Lamp Measurement Report		
7	Electrical Connection Diagram of Lamps and Lanterns		
8	Data of Wireless Network Control System		
9	Instructions on Precision and Service Life of Carbon Dioxide Probe		
10	Instructions on Precision and Service Life of Temperature and Humidity Probe		
11	Design and Calculation of Flow, Pressure and Temperature of Pipe Fittings		
12	Electrical Diagram of Electromagnetic Control Valve		
13	Inspection Report of Pipe Fittings Materials		
14	Test Report of Planting Groove and Planting Box Materials		
15	Inspection Report on Material of Liquid Storage Tank		
16	Design of Ultraviolet Reflux Disinfection and Sterilization		
17	Specification for Disinfection, Sterilization and Cleaning of Hydroponic Systems		
18	Design of Nutrient Solution Regulation and Control System		
19	Failure Nutrient Solution Determination Documents		
20	Description of Planting Technology		
21	Description of Preparation of Inorganic Salt Nutrient Solution		
22	Description of Nutrient Substrates for Integration of Water and Fertilizer		
23	Quality Inspection Report		
24	Heavy Metal Limit Test Report for Products		
25	Third Party Confirmation of Plant Factories Authorized by Contract		
26	Design Handbook of Plant Factories		

Appendix B: Contents and Terms of Plant Factory Design

1、Overview

Type of plant factories

Overview of geographical environment and climate

Overview of planting equipment

Overview of planting technology

Overview of general requirements

2、Contents of Plant Factory Planning

Building requirements

Building structural requirements

Environmental protection requirements of surrounding areas

Water supply and drainage requirements

Power supply and safety requirements

Natural light conditions in planting space

Indoor ventilation specification requirements

Environmental protection requirements for protection and decoration of indoor components

Design requirements of ventilation and dust chamber

Requirements for spacing and passage of planting racks

Requirements for inlet isolation and protection

Plant factory emission requirements

3、Description of Planting Technology

Matrix requirements

Germplasm requirements

Agronomic requirements of different planting varieties

Nutrient solution and parameter control requirements

Indoor temperature and humidity control requirements

Carbon dioxide supply and concentration measurement requirements

Oxygen concentration and measurement requirements

Air composition concentration and ventilation requirements

Requirements for disinfection and sterilization of planting space

Spectral design requirements for planting technology

Requirements for calculation of photon flux density uniformity on planting surface

Compilation specification for planting technology of each vegetable

4、Quality Description

Requirements for vegetable quality inspection

Matrix inspection requirements

Germplasm inspection requirements

Nutrient solution testing requirements

Emission testing requirements for plant factories

5、Description of Equipment and Design

Technical performance parameters of plant light spectrum

Secondary optical design of plant lamp

Electrical performance of lamps

Driving and controlling electromagnetic radiation performance

Accuracy and performance of various sensors

Internet of Things and Internet application description

Environmental protection performance of lamp materials

Design requirements and calculation of temperature regulator

Requirements and calculation of indoor and outdoor ventilation

Design requirements for structural strength of planting racking

Design and calculation of planting racking height

Material requirements for planting grooves and pipes

Design requirements for carbon dioxide supply

Requirements for disinfection and sterilization of indoor and planting equipment

Requirements for protection and disinfection of indoor workers

6、Total Energy Consumption and Energy Consumption Design of Plant Factories

Estimated energy consumption of equipment

Energy balance

7、Cost Estimation and Primary Techno-economic Analysis

Estimation of Unit Cost

ROI Analysis

8、Purchased Parts List

Purchased parts need to conform to general requirements and be easy to purchase.

9、Wearing Parts List

10、Consumption Material List

11、List of Implementation Standards

According to the requirements of this standard and provide plant factory construction data filing form.

12、Third-Party Confirmation of Plant Factories

Letter of authorization for Third-Party confirmation of contract terms