SPECIAL CITY COUNCIL MEETING

July 19, 2023 at 6:30 PM

City Council Chambers, 16 Colomba Rd.

DeBary, Florida 32713

MINUTES

CALL TO ORDER: Mayor Chasez called the meeting to order at 6:30 p.m.

ROLL CALL: Mayor Chasez, Vice-Mayor Butlien, and Council Members Pappalardo, Sell and Stevenson are present.

Others present: Carmen Rosamonda, City Manager; Giffin Chumley, City Attorney; Steven Bapp, Growth Management Director; Elizabeth Bauer, Finance Director; Wesley Grissom, Deputy Finance Director; Annette Hatch, City Clerk; and, David Rodriguez, Information Technology Technician.

PUBLIC PARTICIPATION: For any items **ON THE AGENDA**, citizen comments are limited to five (5) minutes per speaker. Speakers will be called when the item is introduced for discussion.

DELETIONS OR AMENDMENTS TO THE AGENDA (City Charter Sec. 4.11): None.

PUBLIC HEARINGS:

Staff is requesting City Council approve the second reading of Ordinance No. 05-2023, amending the Progress Industry Park Industrial Planned Unit Development (IPUD) to permit a Hydrogen Production and Storage Facility (the Facility) project. (Quasi-Judicial)

Mayor Chasez reviewed the City's quasi-judicial process.

City Attorney read the Ordinance into the record.

City Clerk swore in all those who wished to speak.

Mayor Chasez stated she had spoken with the General Manager of the facility. No other Council Members had ex-parte communications to disclose.

Staff reviewed the amended language requested at the previous hearing. An email from Duke Energy listing the engineering firms, agencies and codes/regulations was distributed to all Council Members. (A copy of which is attached to these minutes).

Richard Zwolak, Duke Energy, addressed Council and reviewed the amended changes.

Robin Hardy addressed Council.

Richard Zwolak, re-addressed Council.

Motion by Vice-Mayor Butlien to approve the second reading of Ordinance No. 05-2023. Seconded by Council Member Pappalardo. Motion passed unanimously.

Staff is requesting City Council approve the first reading of Ordinance No. 07-2023, amending the Comprehensive Plan's Future Land Use Map (FLUM) to change the Future Land Use classification of the parcel addressed as 450 South Charles Richard Beall Boulevard (parcel ID # 900400000110) from Commercial/Retail (C/R) and Industrial/Service (I/S) to exclusively I/S.

City Attorney read the Ordinance into the record.

Staff reviewed the Future Land Use Map changes and consistency with the City's Land Development Code.

Michael Wojtuniak, Florida Public Utilities Project Engineer, addressed Council.

Motion by Council Member Stevenson to approve the first reading of Ordinance No. 07-2023. Seconded by Vice-Mayor Butlien. Motion passed unanimously.

Staff is requesting City Council approve the first reading of Ordinance No. 08-2023, amending the Zoning Map to rezone the parcel addressed as 450 South Charles Richard Beall Boulevard (parcel ID # 900400000110) from Shopping Center (B-3) and Light Industrial (I-1) to exclusively I-1. (Quasi-Judicial)

City Attorney read the Ordinance into the record.

City Clerk swore in all those who wished to speak.

There was no ex-parte communication to disclose.

Staff stated the request complies with the City's Corridor Overlay regulations and is consistent with surrounding zoning.

No one addressed Council.

Motion by Vice-Mayor Butlien to approve the first reading of Ordinance No. 08-2023. Seconded by Council Member Pappalardo. Motion passed unanimously.

NEW BUSINESS:

City Manager requests City Council present the Proposed FY 2023-24 Budget.

City Manager reviewed the City's financial accomplishments, proposed budget, rollback rate, options for major projects, non-ad valorem assessments and operational expenses.

This was an informational item. Council Members discussed the presentation. No motion or voting took place.

City Manager is requesting City Council adopt Resolution No. 2023-05 to set the proposed ad valorem millage rate of 2.9247 for fiscal year 2023/2024 and to set the date, time, and place of the tentative budget hearing on the fiscal year 2023/2024 budget for September 6, 2023 at 6:30 PM in the Council Chambers at City Hall. Council may set the proposed millage rate higher than the City Manager's recommendation.

City Attorney read the Resolution into the record.

Staff briefly reviewed the draft budget and proposed millage.

No one addressed Council.

Motion by Vice-Mayor Butlien to approve Resolution No. 2023-05. Seconded by Council Member Stevenson. Motion passed unanimously.

City Manager is requesting City Council adopt Resolution No. 2023-06 to set the Solid Waste Non- Ad Valorem Assessment for fiscal year 2023/2024 at $250.00 per residential unit.

City Attorney read the Resolution into the record.

Staff briefly reviewed the solid waste rate breakdown.

No one addressed Council.

Motion by Vice-Mayor Butlien to adopt Resolution No. 2023-06. Seconded by Council Member Pappalardo. Motion passed unanimously.

City Manager is requesting City Council adopt Resolution No. 2023-07 to set the Stormwater Non- Ad Valorem Assessment (NAVA) for fiscal year 2023/2024.

City Attorney read the Resolution into the record.

Staff briefly reviewed the stormwater rates.

No one addressed Council.

Motion by Council Member Stevenson to adopt Resolution No. 2023-07. Seconded by Vice-Mayor Butlien. Motion passed unanimously.

City Manager is requesting City Council adopt Resolution No. 2023-08 to set the Street Lighting Districts Non- Ad Valorem Assessments for fiscal year 2023/2024.

City Attorney read the Resolution into the record.

Staff reviewed the assessments.

No one addressed Council.

Motion by Vice-Mayor Butlien to adopt Resolution No. 2023-08. Seconded by Council Member Stevenson. Motion passed unanimously.

City Manager is requesting City Council adopt Resolution No. 2023-09 to set the Orlandia Heights Neighborhood Improvement District Non- Ad Valorem Assessment for fiscal year 2023/2024 at $300.00 per parcel.

Staff reviewed the District's budget and assessment.

No one addressed Council.

Motion by Vice-Mayor Butlien to adopt Resolution No. 2023-08. Seconded by Council Member Stevenson. Motion passed unanimously.

COUNCIL MEMBER REPORTS / COMMUNICATIONS:
Member Reports/ Communications

A. Mayor and Council Members

B. City Manager

C. City Attorney

DATE OF UPCOMING MEETING / WORKSHOP: Regular City Council Meeting August 2, 2023, 6:30 p.m.

ADJOURN: The meeting was adjourned at 8:39 p.m.

APPROVED:

CITY COUNCIL
CITY OF DEBARY, FLORIDA

____
Karen Chasez, Mayor

____
Annette Hatch, CMC, City Clerk

Steven Bapp

Subject: FW: [EXTERNAL] RE: Regulatory agencies for Hydrogen Production
Attachments: HY-M000100 - Design Criteria Rev.1.pdf

From: Hackey, John [mailto:John.Hackey@duke-energy.com]
Sent: Wednesday, July 19, 2023 13:05
To: D'Alessandro, Patricia M <Patricia.D'Alessandro@duke-energy.com>; Cooper, Kristen <Kristen.Cooper@duke-energy.com>
Cc: Hoeflich, Peter C <Peter.Hoeflich@duke-energy.com>; Steven Bapp <SBapp@DeBary.org>; Pompee, Clift <Clift.Pompee@duke-energy.com>
Subject: RE: [EXTERNAL] RE: Regulatory agencies for Hydrogen Production

Patricia,
Below I have added our engineering firms, agencies and codes/regulations.

Hydrogen Production Design Engineer: Sargent and Lundy (see attached design criteria and below for specific codes)
Turbine Design Engineer: General Electric
Air Quality: Regulated by FDEP and EPA for our Title V Air Permit. C.E.M. Solutions system process data for these agencies. There are 3 annual inspections required. Quarterly to FDEP, Semi-annually to FDEP and EPA, and Annually to the FDEP and EPA
America Electric Gas Insurance Services (AEGIS): They are reviewing our detail designs and ensuring we are following best practices for hydrogen use.
Department of Treasury: (see Bill IIJA) defines the criteria for what is green hydrogen.

The latest version of the following industry codes and guidelines will be used on a program wide basis for the project efforts unless otherwise indicated or required by the Adopted Building Code.
3.1.1 ACI – American Concrete Institute
(1) ACI 318-14 – Building Code Requirements for Structural Concrete and Commentary
3.1.2 AISC – American Institute of Steel Construction
(1) AISC 360-16 - Manual of Steel Construction, Allowable Stress Design (ASD) – 15th Edition
3.1.3 ANSI – American National Standards Institute
3.1.4 API – American Petroleum Institute
(1) API 520 – Sizing, Selection, and Installation of Pressure-relieving Devices, Part II—Installation
(2) API 521 – Pressure-Relieving and Depressurizing Systems
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(1) ASME B16.34 – Valves - Flanged, Threaded, and Welding End
(2) ASME B31.1 – Power Piping Code
(3) ASME B31.3 – Process Piping
(4) ASME B31.12 – Hydrogen Piping and Pipelines
(5) ASME Boiler and Pressure Vessel Code Section VIII Division 1 – Rules for Construction of Pressure Vessels

(6) ASME Boiler and Pressure Vessel Code Section VIII Division 3 – Alternative Rules for Construction of High-Pressure Vessels
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3.1.10 CGA – Compressed Gas Association
(1) CGA G-4.1 – Cleaning of Equipment for Oxygen Service
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(3) CGA G-5.4 – Standard for Hydrogen Piping Systems at User Locations
(4) CGA G-5.5 – Standard for Hydrogen Vent Systems
(5) CGA P-8.7 – Safe Location of Oxygen and Inert Gas Vents
3.1.11 CRSI – Concrete Reinforcing Steel Institute
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(2) NFPA 54 (2018) – National Fuel Gas Code
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(4) Flammable Gas Piping Systems
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(6) IFGC – International Fuel Gas Code
(7) UPC - Uniform Plumbing Code
(8) Florida Department of Transportation Standard Specifications
(9) Florida Department of Environmental Protection
(10) Volusia County Stormwater Management Standards
(11) St. John's River Water Management District Requirements
(12) Florida Erosion and Sediment Control Manual

Thank You,
Johnny Hackey
352-257-1846

From: D'Alessandro, Patricia M <Patricia.D'Alessandro@duke-energy.com>
Sent: Wednesday, July 19, 2023 12:15 PM
To: Hackey, John <John.Hackey@duke-energy.com>; Cooper, Kristen <Kristen.Cooper@duke-energy.com>
Subject: FW: [EXTERNAL] RE: Regulatory agencies for Hydrogen Production
Importance: High

Just received this from city of Debary. Please respond to me with the agencies that will oversee our hydrogen pilot

From: Steven Bapp <SBapp@DeBary.org>
Sent: Wednesday, July 19, 2023 12:12 PM
To: Zwoklak, Richard -wsp <richard.zwolak@wsp.com>; D'Alessandro, Patricia M <Patricia.D'Alessandro@duke-energy.com>
Cc: Joseph Barker <JBarker@DeBary.org>
Subject: [EXTERNAL] RE: Regulatory agencies for Hydrogen Production

Here is what I found thus far, is there any other agencies?

As a result of the structure of the US legal system, the regulation of hydrogen and the relevant regulatory bodies differ state by state. On a federal level however, there are some relevant regulatory bodies, with those most significantly and extensively in a position to influence the development of the hydrogen industry and infrastructure being:

- The **Department of Energy** is a cabinet-level department of the US Government led by the US Secretary of Energy which focuses on policies regarding energy and safety in handling nuclear material.
- The **Federal Energy Regulatory Commission** ("FERC") is the US federal agency that regulates the transmission and wholesale trading of electricity and natural gas, and also regulates the transportation of oil by pipeline. Pursuant to the Natural Gas Act, FERC regulates the siting, construction, and operation of interstate natural gas pipelines and storage, as well as the rates and terms of service that these pipelines offer. The FERC has not used this jurisdiction to regulate exclusively hydrogen pipelines, and may not have the ability to do so under existing statute, but could potentially regulate the transportation of hydrogen if transported in a blended stream with natural gas. With the legislation at present, an Act of Congress will be required to ensure that hydrogen is within the scope of the FERC. Further, such an Act could accordingly separate infrastructure development responsibilities between the FERC and the Department of Transport through the Pipeline and Hazardous Materials Safety Administration.
- The **Occupational Safety and Health Administration** ("OSHA") creates the Occupational Health and Safety Standards, including for compressed gases and hydrogen. Title 29 of the C.F.R. Subpart H, as created by OSHA, covers the installation of hydrogen systems. Consequently, this regulates a wide variety of aspects of hydrogen, including location, containers and piping characteristics, safety relief devices, equipment assembly, marking, and testing.
- The **United States Environmental Protection Agency** ("EPA") regulates substances that could impact human health and the environment, which includes hydrogen. Importantly, it is interesting to note that in the EPA's regulation of hydrogen, hydrogen itself was not necessarily the focal point of the regulatory process. As such, it has been suggested that with the growth of hydrogen the EPA will likely need to revisit this regulatory approach. 49
- The **Pipeline and Hazardous Materials Safety Administration** ("PHMSA") is centered around creating national policy, conducting research, and setting and enforcing industry standards, taken together with the intention of protecting human health and the environment through promoting the safe transportation of energy and other hazardous materials. As of December 2020, it regulated approximately 700 miles of hydrogen pipelines. As with the EPA, it can be considered that, given the primary focus of the regulations is not specifically hydrogen, certain

aspects of hydrogen itself are not fully contemplated in some parts of the existing regulations' design requirements.

Steven E. Bapp, AICP
Growth Management Director
City of DeBary, Florida
386-601-0203
sbapp@debary.org

From: Steven Bapp
Sent: Wednesday, July 19, 2023 11:46
To: 'Zwolak, Richard' <richard.zwolak@wsp.com>; D'Alessandro, Patricia M <Patricia.D'Alessandro@duke-energy.com>
Cc: Joseph Barker <JBarker@DeBary.org>
Subject: Regulatory agencies for Hydrogen Production

Richard and Patty

The question is arising "what regulatory agencies monitor green hydrogen production"? or, what agencies will be conducting safety etc inspections of the Duke site?

Steven E. Bapp, AICP
Growth Management Director
City of DeBary, Florida
386-601-0203
sbapp@debary.org

DUKE ENERGY®

DeBary Power Plant
Vision Florida - Hydrogen Production and Storage Project - Phase 2
Project Design Criteria
HY-M000100

Prepared for:
Duke Energy

Project No. 14621-085
June 2nd, 2023
Revision 1
For Use

Sargent & Lundy

55 East Monroe Street
Chicago, IL 60603-5780 USA

ISSUE SUMMARY PAGE

PROJECT DESIGN CRITERIA

FOR
VISION FLORIDA HYDROGEN PROJECT
AT THE
DEBARY POWER PLANT

DUKE ENERGY

REVISION	ISSUE PURPOSE	ISSUE DATE	SECTIONS AFFECTED
1	For Use	6/02/2023	ALL

REVISION	PREPARED	REVIEWED	APPROVED
1	**Electrical** Digitally signed by Taylor Pokraka Date: 2023.06.02 10:04:48-05'00' T. Pokraka	**Electrical** Digitally signed by Shadi Yousef Date: 2023.06.02 13:27:35-05'00' S. Yousef	Digitally signed by Casey Loughrin DN: C=US, E=casey.j.loughrin@sargentlundy.com, O=Sargent & Lundy, CN=Casey Loughrin Date: 2023.06.02 13:52:21-05'00' C. Loughrin
	Instrumentation & Controls Mila Sebesta Digitally signed by Mila Sebesta Date: 2023.06.02 10:08:15 -05'00' M. Sebesta	**Instrumentation & Controls** Mila Sebesta Digitally signed by Mila Sebesta Date: 2023.06.02 11:44:35 -05'00' M. Sebesta signing for D. Zilly	
	Mechanical Ethan Bredemeier 2023.06.02 08:52:49 -06'00' E. Bredemeier	**Mechanical** Digitally signed by Marc G Prasse Date: 2023.06.02 10:51:16 -05'00' M. Prasse	
	Civil Cooper Galuza Digitally signed by Cooper Galuza Date: 2023.06.02 08:59:03-05'00' C. Galuza	**Civil** James Perry 2023.06.02 10:55:48-05'00' J. Perry	
	Structural Digitally signed by Christie-Hai T. Ainge Date: 2023.06.02 11:22:54 -05'00' C. Ainge	**Structural** Elizabeth H. LaMere Digitally signed by Elizabeth H. LaMere Date: 2023.06.02 10:46:49-05'00' E. LaMere	

TABLE OF CONTENTS

1.0. INTRODUCTION

The Vision Florida Hydrogen Project is located at DeBary Power Plant Station in DeBary, Florida. The plant consists of 10 units with Combustion Turbine (CT) units 1-6 burning exclusively fuel oil and units 7-10 capable of burning natural gas or fuel oil. Also located at the DeBary Power Plant is 74.5 MW of solar photovoltaic (PV) power generation. The Vision Florida Hydrogen Project focuses on Unit 7 where a General Electric (GE) 7EA.03 dual-fueled combustion turbine (natural gas and fuel oil) will be retrofit and modified to enable the blending of hydrogen and natural gas during gas firing. With the turbine modifications, the blending skid, and new hydrogen production and storage equipment, Unit 7 will be capable of cofiring natural gas and hydrogen for fuel blends from 25-90% hydrogen by volume and firing on 100% hydrogen. There is the possibility of expanding these capabilities to enable the other dual-fueled combustion units (8-10) in the future.

1.1 Hydrogen Production and Storage Overview

The proposed improvements being considered as part of this project include the following major pieces of equipment/systems:

1. 2 x 1 MW Plug hydrogen electrolyzer (PEM) systems that will utilize power from the existing solar field or grid supplied power. Electrolyzer system will include all necessary auxiliary systems, such as: air coolers, instrument air systems, hydrogen purification / dryers, chillers, water treatment, electrical equipment, and more
2. Combustion turbine (CT) modifications required to accommodate hydrogen firing from 0-100% by volume (by GE)
3. Hydrogen compressor, including a cooling system with a fin fan heat exchanger (air-cooler) and closed cooling water pump(s)
4. High-pressure hydrogen gas tube racks for storage
5. Hydrogen pressure control valves
6. Natural gas and hydrogen blending skid (by GE)
7. Nitrogen bottle racks in hydrogen area with regulator valves
8. Nitrogen generator and booster compressor in Water Treatment Building supplying nitrogen to a receiver that feeds the blending skid and CT area purge connections.
9. Instrument air compressors and dryers in Water Treatment Building supplying air to both air receivers in hydrogen island and CT area as well as the nitrogen generator
10. Prefabricated power distribution center (PDC)
11. Pad-mount 34.5kV-480V auxiliary transformers
12. 480V 600A Motor Control Center
13. 4-Way disconnect switch
14. Demineralized water pumps with VFDs
15. Low-pressure hydrogen buffer vessel
16. Temporary hydrogen truck supply connections (HOLD)
17. GE Mark VIe DCS Turbine Control System
18. Emerson Ovation DCS (New controller 02/52 and modified 07/57)

HOLD:
Source of hydrogen for commissioning and equipment required being finalized.

2.0. SITE DATA

2.1 Location

The DeBary Power Plant Station is located in Volusia County, Florida. The address is 176 W Highbanks Rd, DeBary, FL 32713. The plant is located at approximately 28°53'25.85" N (28.890514) Latitude and 81°19'54.77" W (-81.331881) Longitude.

2.2 Site Specific Data

2.2.1 Ambient Conditions

The closest and most representative meteorological station with published climate statistics is Orlando Sanford International Airport in Sanford, Florida (ASHRAE Handbook 2021 WMO: 722057). Orlando Sanford International Airport is located approximately 15 miles southeast of DeBary station.

Table 2-1: Ambient Temperature Conditions

Ambient Temperatures	Dry Bulb	Wet Bulb	Unit	Remarks
Maximum	101.8	83.5	°F	50yr Max DB Extreme Max WB
Minimum	22.3	18.5	°F	50yr Min
Design High Temperature	94.4	75.9	°F	0.4% Cooling DB/MCWB
Design Low Temperature	37.2		°F	99.6% Heating DB

2.2.2 Design Rainfall

Table 2-2: Design Rainfall Conditions

	Rainfall depths (in) [Reference (1)]		
	Storm Return Period		
Rainfall Duration	**25-year**	**50-year**	**100-year**
5-minute	0.849	0.928	1.00
15-minute	1.52	1.66	1.79
30-minute	2.47	2.70	2.91
60-minute	3.37	3.70	4.02
6-hour	5.61	6.37	7.16
24-hour	7.87	9.29	10.9

(1) National Oceanic and Atmospheric Administration (NOAA), 2016: Hydrometeorological Design Studies Center Precipitation Frequency data server. NOAA Atlas 14, Volume 9, Version 2. DeBary, FL. Latitude: 28.8976°, Longitude: -81.3352°. Accessed October 27, 2022.

2.2.3 Electrical Data

Table 2-3: Electrical Power Supplies Available (Nominal Value)

34,500 VAC, 3-phase, 60Hz Electrolyzer Input Power
480 VAC, 3-phase, 60Hz Motor size 0.5 to 250 hp and all Reversing Starters
120 VAC, 1-phase, 60 Hz Motor size < 0.5 hp
120/208 VAC, 3-phase, 60 Hz, UPS Source

2.3 General Unit 7 Information

The DeBary Power Plant Station Unit 7 is equipped with a General Electric (GE) 7EA.03 Combustion Turbine that generates approximately 93 MW in the winter and 74 MW in the summer on natural gas. This information is listed below in Table 4-6.

2.4 Solar Plant Information

The DeBary solar plant was installed in 2020 and generates approximately 74.5 MW with 300,000 panels.

3.0. GOVERNING CODES & PLANT NUMBERING SYSTEM

3.1 Governing Codes

The latest version of the following industry codes and guidelines will be used on a program wide basis for the project efforts unless otherwise indicated or required by the Adopted Building Code.

3.1.1 ACI – American Concrete Institute
- (1) ACI 318-14 – Building Code Requirements for Structural Concrete and Commentary

3.1.2 AISC – American Institute of Steel Construction
- (1) AISC 360-16 - Manual of Steel Construction, Allowable Stress Design (ASD) – 15th Edition

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3.2 Plant Numbering System

S&L will follow the current DeBary tagging and numbering system. Duke has provided mechanical numbering in Attachment 1.

Both English and SI units and language shall be used for all documents.

4.0. GENERAL HYDROGEN PRODUCTION AND STORAGE DESIGN DATA

The Vision Florida Project will be based upon the conceptual design assumptions summarized below.

4.1 General

The new PEM hydrogen electrolyzer systems will be 2 x 1 MW in size. Table 4-1 details the major technical data for the electrolyzer equipment. Table 4-2 details the hydrogen gas analysis produced by this electrolyzer.

Table 4-1: Hydrogen Electrolyzer Design Parameters

Parameter	Units	Hydrogen Value	Source/ Notes
Quantity	-	2	Plug Proposal
Size	MW	1	
Turndown ratio	%	10 to 100	
Ramp time up – min to max	s	30	
Cold startup time	s	300	
Nitrogen pressure requirements (min /max)	barg. (psig)	68.9 / 207 (1,000 / 3,000)	Plug PFD
Expected stack life	hrs.	80,000	Plug Proposal
Stack technology	-	PEM water electrolysis	

Table 4-2: DeBary Hydrogen Gas Fuel Analyses

Parameter	Units	Hydrogen Value	Source/ Notes
Maximum net production rate (per electrolyzer)	kg/hr (lbm/hr)	19 (41.9)	Plug PFD
Delivery pressure – nominal	psig	580	
Product quality	-	> 99.999% H_2 (<5ppm H_2O, <5ppm O_2)	
System efficiency at full output at ISO standard day conditions	-	75%	Plug Proposal
Nominal electricity consumption (stack level/plant level)	kWh/kg	53.6 / 58.8	
Hydrogen outlet temperature	°F	73-86	Plug PFD

4.2 Demineralized Water

Demineralized water will be required for the electrolyzer system. As is typical for megawatt-scale containerized electrolyzers, water treatment systems are contained within the electrolyzer packages. Plug only requires potable water quality as input, however for this project we are able to tie into the existing DeBary demin water tank to provide higher quality water to the electrolyzers. Demineralized water is also required for the combustion turbine to mitigate thermal nitrogen oxide (NOx) formation from the burning of both fuel gas and hydrogen. Based on GE's calculations based on load profile, the maximum injection flow that is required is 130 gpm – to target 42 ppmvd NOx – when firing at 90% hydrogen blends on the coldest day. The existing NOx Injection Pumps are rated for 160 gpm at 690 psig developed head which provides ample flow to account for the different blends of hydrogen and fuel gas while limiting 42ppmvd NOx in the turbine exhaust.

Table 4-3 details the existing DeBary demineralized water analysis and the requirements for the new electrolysis equipment. General Electric provide NOx injection flowrate requirement changes.

Table 4-3: DeBary Demineralized Water

Variable	Unit	Requirement	Source/ Notes
Electrolyzer (per system)			Plug PFD
Consumption rate at rated production	GPM	3 – 7 (intermittent)	
Pressure range	Barg (psig)	3.45 - 6.9 (50 – 100)	
Temperature range	°C (°F)	13-30 (55-86)	
Maximum flowrate by fuel to target 42ppmvd NOx			
90% Hydrogen 10% Fuel Gas	GPM	129	GE: MLI 0314
100% Fuel Gas	GPM	113	GE: MLI 0314
100% Liquid Fuel (Fuel Oil)	GPM	117	GE: MLI 0314

4.3 Instrument Air

The two (2) electrolyzers each contain their own instrument air equipment designed only to provide instrument air within their skids, therefore, a separate air system is needed for all pneumatic valves and equipment outside electrolyzer vendor scope in the hydrogen area.

A new instrument air system is required to meet the pressure requirements for the GE blending skid. Two (2) Air Compressors (2x100%) will supply one (1) Wet Air Receiver before the air is dried by two (2) new Instrument Air Dryers (2x100%). The dry air will supply the nitrogen generator and system as described in the following section, the two (2) Instrument/Dry Air Receivers – one in the hydrogen island and the other in the CT area – and the existing service air system to supply additional pressure to the unit when sufficient pressure is available to the instrument air users. All three receivers shall be designed, inspected, and tested under ASME Section VIII.

4.4 Nitrogen

The nitrogen system will be separated into two systems – a high-purity (99.999%) and low-purity (99.9%). The electrolyzers require high purity nitrogen for purging and to avoid damaging the internal equipment, while the GE blending skid only requires 99.75% or low-purity nitrogen. The nitrogen required during hydrogen firing is sufficient enough to warrant a low-purity nitrogen generator instead of bottle racks. The instrument air dryers will supply dry air to a PSA (pressure swing adsorption) nitrogen generator, sized with margin to meet the leak by consumption of nitrogen during hydrogen firing. The generator supplies the low-purity nitrogen to a compressor, which increases the pressure to 2,000 psig. The high-pressure nitrogen is forwarded to the nitrogen receiver – designed, inspected, and tested under ASME Section VIII. The receiver tank contains sufficient usable nitrogen for two (2) emergency purges and two (2) starts on hydrogen for the blending skid. Downstream of the nitrogen receiver, there are two pressure regulating valves in parallel with setpoints of 480 psig and 490 psig. The smaller capacity regulator with the higher setpoint is used for continuous leakage consumption when hydrogen is utilized in the turbine. The larger capacity regulator with the lower setpoint is used in tandem with the smaller capacity regulator for transient high flow demand periods during hydrogen starts and purging in an emergency case. The low-purity nitrogen is also capable of purging the piping for maintenance purposes in the CT area. GE requires a minimum of 410 psig and a maximum of 435 psig of Nitrogen at the skid boundary in order to purge the system. Under normal operation the flowrate of nitrogen required is 0.014 lbm/sec (11.4 SCFM) for block valve leakage. During a purge sequence the flowrate of Nitrogen required is 1.2 lbm/sec (975 SCFM). Prior to hydrogen start, the total mass required is 24.4 lbm of nitrogen. During a combustion turbine trip, the mass of nitrogen required is 87.2 lbm.

The other nitrogen system, divorced from the GE blending skid system, utilizes high-purity nitrogen bottle racks instead of a nitrogen generator. The bottle racks will be installed in the hydrogen production area only. Each bottle rack will supply inert gas to the equipment in the hydrogen island or piping that may contain hydrogen gas and will need purging for maintenance. Each pack will contain 8 nitrogen bottles.

There are two types of purge events – operational purging and maintenance purging. The electrolyzers and blending skid will both be directly connected to the nitrogen system to enable operational purging. Maintenance purging enables hydrogen to be safely removed from piping sections in order to perform maintenance on equipment or piping. Typical consumption of nitrogen is listed as 38 SCF per purge per electrolyzer – resulting in 76 SCF per purge for the two electrolyzer systems. The flowrate of nitrogen will range between 3-8.5 SCFM. The total volume of all hydrogen piping is approximately 325 cubic feet. The hydrogen storage's water volume is 6,328 cubic feet. Total weekly consumption will vary on use profile and the need for maintenance.

4.5 Expected Hydrogen Production Operation

Table 4-4 includes the expected hydrogen production data following the installation of two (2) 1 MW Plug PEM Electrolyzer systems.

Table 4-4, Expected Hydrogen Production Operation

Variable	Units	Design	Source/ Notes
Hydrogen production	kg/hr (lbm/hr)	2 x 19: 38 total (2 x 41.9: 83.8 total)	Plug PFD DWG: 0000031573 SH1
Quality of Hydrogen	-	99.999%	
Outlet Pressure of Hydrogen	barg (psig)	30-40 (435-580)*	
Life Expectancy (Stack)	hrs	80,000	
Design Basis	-	ISO 22734 & NFPA 2	
* 580 psig is the normal operating pressure.			

4.6 Expected Hydrogen Storage Operation

Table 4-5 includes the expected hydrogen storage data following the plant retrofit.

Table 4-5, Expected Hydrogen Production Operation

Variable	Units	Normal Operating	Design
Usable capacity	kg (lbm)	-	2,493 (5,496)
Total capacity	kg (lbm)	-	2,855 (6,295)
Storage pressure	psig	3,600	4,000

4.7 Expected Unit 7 Combustion Turbine Power Output and Heat Input

Table 4-6 includes the expected power output and heat input at full load for the Combustion Turbine for Summer and Winter cases following the plant retrofit.

Table 4-6, Expected Unit 7 Combustion Turbine Power Output and Heat Input (at Full Load)

Variable	Units	Summer	Winter	Source/ Notes
Power Output	MW	74	93	Per GE
Heat Input	MMBTU/hr	939	1,132	Per GE

4.8 Redundancy

The facility is currently envisioned with typical pilot plant features with limited redundancy, although S&L recommends that some consideration be given for potential N+1 redundancy in the auxiliary support systems that are essential to the main process, given that these are typically very low-cost items.

On the following page in Table 4-7, 100% indicates the quantity needed for the Plant.

Table 4-7, Plant Redundancy

Equipment and System	Redundancy
Electrolyzer System and Auxiliaries	2 x 50%
Hydrogen Low Pressure Buffer Vessel	1 x 100%
Hydrogen Compressor	1 x 100%
Hydrogen Storage Tube Racks (66 tubes total)	1 x 100%
Demineralized Water Pumps	2 x 100%
Fin-Fan Heat Exchangers	1 x 100%
Compressor Lube Oil Auxiliary Rotating Equipment	2 x 100%
Instrument Air Compressors	2 x 100%
Instrument Air Dryers	2 x 100%
Instrument/Dry Air Receiver (Unit 7)	1 x 100%
Instrument/Dry Air Receiver (HPSS)	1 x 100%
Nitrogen Generator	1 x 100%
Nitrogen Compressor	1 x 100%
Prefabricated Power Distribution Center	1 x 100%
Pad-mount 34.5kV-480V auxiliary transformer	1 x 100%
Pad-mount 34.5kV-480V electrolyzer transformers	2 x 50%
480V 600A Motor Control Center	1 x 100%

5.0. MECHANICAL DESIGN BASIS

The Vision Florida Project study will be based upon the conceptual design assumptions summarized below.

5.1 Hydrogen Electrolyzers

The demin water pumps will supply the PEM electrolyzer systems for hydrogen production. Within the electrolyzer stacks, a voltage is applied across the membranes that will split the demin water into gaseous hydrogen and gaseous oxygen. The gaseous oxygen produced by the system will be vented directly to the atmosphere at a safe location above the electrolyzer system and outdoors. The result will be a gaseous hydrogen product >99.999% purity at 40 barg (580 psig). Table 4-1 above outlines the electrolyzer design parameters provided by the vendor. The electrolyzer systems requires instrument air to operate, and nitrogen for purging. The instrument air for the systems will be supplied in the Plug containers.

5.2 Hydrogen Compressor

The electrolyzers will discharge hydrogen gas to the Low-Pressure Hydrogen Buffer Vessel – designed, inspected, and tested under ASME Section VIII – to act as a means of minimizing surges and transients to the Hydrogen Compressor suction. The compressor will be a diaphragm type and driven by a low voltage electric motor. The compressor will further pressurize the hydrogen stream to just above the maximum storage pressure of 3,600 psig accounting for pressure losses. The compressor OEM will provide auxiliary compressor systems, such as lube oil and cooling systems, as needed. Interstage and after cooling, as needed, will be integrated onto the compression skid. Table 5-1 provides more details on the hydrogen compressor.

Table 5-1, Hydrogen Compressor Design Data

Parameter	Units	Operating	Design
Suction Pressure	psig	575	640
Suction Temperature	°F	73-115	150
Discharge Pressure	psig	3,600	4,000
Discharge Temperature	°F	<140	150
Flowrate	kg/hr (lbm/hr)	36 (79.4)	38.3 (84.7)
Power Required	HP	75	N/A
Cooling Requirement	kW	By Vendor	N/A

5.3 Hydrogen Storage System

The compressor will discharge the compressed hydrogen stream to the high-pressure hydrogen storage system consisting of storage tubes in racks and manifolded together with small bore piping. The storage system design enables future expansion to greater capacities if desired in the future. Pressure transmitters will monitor the pressure in the storage system to ensure safe operation. To supply the hydrogen to the blending skid, the hydrogen will discharge from the storage manifold. The hydrogen will pass through 22 parallel pressure control valves with varying downstream setpoints between 350 psig and 400 psig. Each set of valves associated with a setpoint will operate on the same PID controller. These valves will be globe type and control pressure to three pressure indicating transmitters at the beginning of the 8" header.

The new fixed hydrogen storage system is sized based on providing nearly 2,500 kg (5,525 lbm) of usable storage. At flowrates associated with combustion turbine operation at 100% hydrogen and at full load, the 2,500 kg of usable storage will be depleted in approximately 16 minutes. At the flowrate associated with a 25 vol% hydrogen blend, the hydrogen flow can last nearly 7 hours at 50% combustion turbine load.

After the initial fill, some of the hydrogen becomes trapped based on the minimum system pressure, the total amount of hydrogen stored on site will equal approximately 2,860 kg (6,321 lbm). The hydrogen storage maximum operating pressure of 3,600 psig was chosen over 3,000 psig because the NFPA 2 setbacks are both in the same category of pressure, but the 3,600 psig tubes were more economical for the project and the proportion of usable storage increases with increasing the maximum storage pressure.

The minimum pressure for the storage system of 380 psig is based on the minimum required pressure of 310 psig at the inlet of the blending skid. This includes the added pressure to account for pressure drop across valves and piping between the storage and the blending skid. The hydrogen tubes are 40 ft long and approximately 24 inches in diameter. Each tube holds roughly 717 gallons of water volume. The hydrogen tubes will be made per ASME Section VIII, Division 1 constructed of type I steel tubes. These pressure vessels will undergo inspection and testing per ASME Section VIII. These tubes will be mounted in fixed storage racks. Two racks will contain 18 tubes (3 wide by 6 tall) while the other two racks will contain 15 tubes (3 wide by 5 tall). Every three tubes will be manifolded together. More specifically, there will be 22 manifolds of three tubes due to the NFPA 2 setback restrictions on the internal diameter of the piping and the high flowrates demanded by the blending skid.

Table 5-2, Hydrogen Storage Design Data

Variable	Units	Design
Minimum Operating Pressure	psig	380
Maximum Operating Pressure	psig	3,600
Maximum Allowable Working Pressure	psig	4,000
Normal Operating Temperature	°F	Ambient to 140
Design Temperature	°F	200
Total Capacity	kg (lbm)	2,855 (6,295)
Tubes Required	-	66
Footprint (3 columns x 6 rows)	ft	42 x 7 x 13
Usable Capacity	kg (lbm)	2,493 (5,496)
Usable Capacity – Percentage of Total	-	87.6%

5.4 Piping System Design

All piping system design and material selection shall be in accordance with ASME B31.1 and B31.12, as appropriate. Non-standard pipe sizes shall not be used. Carbon steel schedules such as 160 and XXS will be specified for stainless steel piping if 80S is not sufficient for the application. All hydrogen systems will be designed per B31.12 and all other systems will be per B31.1. It may be acceptable for vendors to use B31.3 for hydrogen piping and shall be evaluated on a case by case basis. Design conditions (temperature, pressure, flow, etc.) for system modifications shall match the existing system design conditions. Different piping materials will be utilized for the different systems present. Table 5-3 presents the materials to be selected based on the system.

Table 5-3: Materials by System and Pressure Testing

Piping System	Above Grade	Below Grade	Testing
Demin Water	316 SS	HDPE	Hydrostatic
Hydrogen	316/316L SS	N/A	Hydrostatic
Fuel Gas	304 SS	N/A	Hydrostatic
Instrument Air	304/304L SS	N/A	In-service
Nitrogen	A106 CS	N/A	Hydrostatic
Waste Water	A106 CS	HDPE	In-service
Storm Water	N/A	HDPE/PVC	In-service

Piping, pipe supports, and pipe accessories will be designed to resist project-specific loads, current building code-specified loads, and loads from the applicable codes and standards in accordance with ASME B31.1, ASME B31.12, ANSI MSS SP-58 (Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation), and ANSI MSS SP-69 (Pipe Hangers and Supports - Selection and Application). Pipe support hangers, fittings, clamps, etc. shall be galvanized. All auxiliary steel used in pipe supports shall be painted to match the in place structural support steel. Existing pipe supports and auxiliary steel shall be reused to the extent possible.

All piping 2" NPS and smaller shall be field routed and supported by installing Contractor, unless the piping is used for hydrogen service – all hydrogen piping will be designed and routed per isometrics. Field routed piping shall not be routed through walkways or equipment removal aisles. All 2" piping and below will be socket weld construction with larger piping being buttwelded with flanges at valves and equipment where needed – with the exception of hydrogen piping. Hydrogen piping will be welded construction where possible to minimize leak points. Mechanical connections will be utilized for hydrogen only when required for equipment, valves, and other piping components. A walkdown shall occur with the installation contractor for small, field-routed piping.

Relief systems will be provided for all systems, as required. All relief systems will comply with ASME Section VIII code and be routed to an appropriate location. All isolation or vent valves in hydrogen system will include double block and bleed isolation. The preferred manufacturers for PSVs are Dresser Consolidated, Kunkel, and Anderson Greenwood.

Piping is sized to reduce the amount of material to be procured, meeting the noise requirements outlined in section 5.6, and limiting the velocities based on the various process flow rates, and minimize NFPA

2 setbacks for hydrogen piping. The piping will be sized to remain below the maximum velocities for the different systems below:

- Liquid Systems
  - Water
    - Under 2"
      - Pump Suction – 3 fps maximum
      - Pump Discharge – 6 fps maximum
    - 2" – 6"
      - Pump Suction – 5 fps maximum
      - Pump Discharge – 10 fps maximum
  - Gravity Drains – 4 fps
- Gaseous Systems
  - Hydrogen – variable based on B31.12 erosional velocities and engineering best practices applying a 75% factor to the B31.12 equation.
  - Air – 4,000 fpm
  - Nitrogen – 4,000 fpm
  - Oxygen (vents only) – 8,000 fpm

5.5 Freeze Protection

Freeze protection (heat tracing) is included in the system design based on the low design temperature from ASHRAE of 22.3 °F. Insulation will be provided for the aboveground water piping and drains to prevent freezing at minimum ambient temperatures. Instruments for water service will need freeze protections since the sensing lines are static (no flow). As no exposed piping is expected to operate above 140 °F, no personnel protection insulation is expected to be necessary for the system. The insulation material will be 850 °F Mineral Fiber ASTM C547-15 Type I with a Jacketing material of Aluminum (Dull) [Gauge 26 B&S].

5.6 Noise

All equipment will be specified to meet the noise requirements of less than 85 dB, A-weighted, at 3 ft.

5.7 Fire Protection & Gas Detection

The existing DeBary site has an existing fire protection system equipped with firewater loops and hydrants around the former fuel oil tank where the new hydrogen equipment will be located. This project will utilize this stretch of firewater piping and hydrants to cover the new hydrogen production, compression, and storage equipment, as required. Additional fire protection systems are not envisioned as a part of this project but will be evaluated. Modifications to the existing Unit 7 fire protection systems will need to be evaluated by GE.

Gas detection and / or flame detection systems will be installed in any new enclosures where hydrogen might be present such as the electrolyzer containers and the blending skid enclosure. The gas and / or flame detectors will be tied to the Emergency Shutdown System (ESS) and will be located per NFPA guidance. Additional area gas and / or flame detectors for outdoor areas will be evaluated. A fire alarm system consisting of smoke detectors, pull stations, exterior strobes, and interior strobes swill be installed in the new PDC enclosure and tied into the plant's existing fire detection system. The combustion turbine retrofit OEM will be responsible for all fire protection and gas and / or fire detection systems related to the blending skid and the turbine itself.

6.0. ELECTRICAL DESIGN BASIS

6.1 Electrical

The electrical power will be sourced from the solar farm high side 34.5kV collector bus. This 34.5kV collector bus is one of three substation circuits that connects the power from the solar farm to the 34.5kV substation. The power is available whether the solar farm is operating or not by back feeding through the 34.5kV substation when the solar farm is not operating. The new 34.5kV source direct buried feeder cables will be tied into an existing deadbreak junction box. Using a new 4-way disconnect switch the source will be distributed between the two (2) 34.5kV-480V electrolyzer system transformers and the one 34.5kV-480V auxiliary transformer. The auxiliary transformer will feed a 480V motor control center, housed in a PDC, that will distribute power to the electrolyzer auxiliary power users and hydrogen system auxiliaries. A self-contained DC/UPS battery system will be provided in the PDC for emergency and control power needs. The existing water treatment MCC's (CAPC-MCC-001 & CAPC-MCC-002) will distribute power to auxiliary power users located near the existing unit and provide backup power to the UPS system. All electrical equipment and enclosures in the presence of hydrogen will be rated Class I, Division 2, Group B except for a 3 foot radius around venting points which will be classified as Class I, Division 1, Group B. All electrical equipment and enclosures on the blending skid will need to be rated Class I, Division 2, Groups B/C/D. These requirements are per NFPA 70 and 497.

S&L plans to meter power at the main power feed to the 4-Way disconnect switch via a Universal Jemstar II Meter to monitor system performance and system power use.

6.2 4-Way Disconnect Switch

The 4-Way disconnect switch will be used to distribute power at the 34.5kV level.

The disconnect switch will be 4-way with the source fused and the feeders fused rated for 200A, 25kA, and 35kV.

6.3 Auxiliary Transformers

The three transformers will each step down 34.5kV medium voltage power to 480V low voltage power. The one (1) auxiliary transformer will be three -phase, two winding, 60 Hz, AL Windings, outdoor, dry-type, unit substation type 500kVA rated w/ 22kV MCOV surge arrestors on each phase. The two (2) Electrolyzer system transformers will be three -phase, two winding, 60 Hz, AL Windings, outdoor, dry-type, unit substation type 2500kVA rated w/ 22kV MCOV surge arrestors on each phase.

Cable will be used to connect the high side and secondary side of the transformer.

6.4 Motor Control Center

The low voltage MCC will supply auxiliary power to loads greater than 1/2HP and up to and including 250HP. The low voltage MCC will be designed for operation under the following service conditions and ratings: 480V, 600A, 65kA 3-phase 3-wire.

Motor Control Center suitable for indoor service in power generating and distribution facilities will be provided. Each low voltage motor control center will consist of one or more vertical sections, bolted together to form a rigid, free standing assembly. Enclosure type will be NEMA 1 suitable for installation indoors. MCC will be front access only.

Feeder Circuit breakers will be 600V, 60Hz, and 3-pole. Circuit breakers will be molded case, draw-out, thermal magnetic type. Exceptions are circuit breakers to Resistance Welding and heater circuits; they will be 600V, 60Hz, three-pole with instantaneous magnetic-only trip units. For circuits requiring a circuit breaker frame size greater than 250A, an electronic trip unit will be used.

Motor starters for 480V service will include 480V circuit breakers, 480V, 3-phase, 60Hz contactors with manual reset electronic overload relays, 120VAC or 460VAC operating coils and control power transformers. Motor starters will not be smaller than NEMA Size 1. Circuit breakers for motor starters will be 600V, 60Hz, three-pole with instantaneous magnetic only trip units.

- Control transformers will be rated at a minimum of 100VA.
- MCC will be provided with a main circuit breaker for the incoming feeder from the 480V transformer.
- MCC feeders will be manually operated thermal magnetic circuit breakers. For circuits requiring a circuit breaker frame size greater than 250A, an electronic trip unit will be used.
- Contactors for heaters, etc. will not be smaller than NEMA Size 1.
- Minimum bucket size will be minimum 12 inches.
- All feeder circuit and motor starter buckets will be capable of being Locked Out/Tagged Out.

6.5 Low Voltage Distribution

Low voltage distribution transformers are used to step down power from 480V to 120VAC single phase or 480V to 120/208V three phase.

- Insulation system and average winding temperature rise will be Class 185 with 115 C rise.
- Transformer insulation system will be UL rated.
- All insulation materials will be flame-retardant and will not support combustion as defined in ASTM Standard Test Method D635.
- Core and coil assembly will be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency will be tested in accordance with NEMA TP2.
- All transformers will have resin encapsulated, aluminum or copper primary winding and secondary winding. The material choice is open to Onward Energy's preference.
- Low voltage distribution panels are used to distribute 120V single phase or 120/208V three phase power.

- The distribution panels and transformers will be designed to be housed in the MCC. All components of the distribution panel will be mounted on a common frame, completely assembled and factory tested. The distribution panel components will be electrically isolated from the frame.
- The power distribution panel includes the following:
    - Main circuit breaker
    - Feeder circuit breakers
    - Main bus
    - Neutral bus
    - Grounding bus
- Panelboards will have vertically aligned continuous aluminum or copper bus bars. Joints are not permitted in the vertical bus. The material choice is open to Onward Energy's preference.
- Bus bars will have sufficient cross-sectional area to meet UL 67 temperature rise requirements through actual tests.
- Bus bars will be phase-sequenced and rigidly supported by high impact resistant, insulated bus supporting assemblies to prevent vibration or short circuit mechanical damage.
- Split solid neutral bus will be plated and located in main compartment for all incoming neutral cables to be same length. Neutral bus will be rated 100%.
- An isolated ground bus will be included.
- Lugs will be rated for 75°C terminations.
- Circuit Breakers:
    - Main and branch circuit breakers will be bolt-on, fully rated, quick-make, quick break, and trip indicating.
    - All circuit breakers will have thermal and magnetic trip elements in each pole.
    - Circuit breakers with the following minimum interrupting capacities will be provided:
    - 120V applications: 10,000 amperes, RMS symmetrical
    - 240V applications: 10,000 amperes, RMS symmetrical

6.6 UPS

The self-contained UPS system will provide uninterruptible power to the control system under emergency loss of AC power conditions. The integral battery rating will be sized such that power will be maintained for a minimum of 2 hours, in the event of loss of AC power.

The UPS system will be backed up from the existing units water treatment MCC (CAPC-MCC-001) via an ATS.

6.7 ATS

The ATS will provide a method of switching source power to the UPS system from the PDC MCC to the existing water treatment MCC (CAPC-MCC-001) during a loss of main AC power. The ATS will be indoor rated, 30A, 4-pole, and 480VAC.

6.8 Cables

Medium Voltage Power Cables

- Medium voltage power cables, will be copper and shielded with tape for all applications
- All three conductor medium voltage power cables will include an integral ground conductor(s).

- Single conductor medium voltage power cable circuits will include an insulated ground conductor. Single conductor cable can be triplexed or placed in triad configuration.
- Insulation will be EPR or TR-XLPE, 133% rated for 105 °C conductor temperature. Jackets will be LLDPE or CPE.
- Maximum conductor size will be 750KCMIL for all medium voltage cables.
- The minimum conductor size will be #4/0 AW for all medium voltage cables.

Low Voltage Power Cables

- 600V low voltage power cable will have flame retardant EPR or flame retardant XLPE insulation rated for 90°C and the conductors will be copper.
- CPE or LSZH jackets will be provided for single conductor and multi conductor cables.
- All three (3) conductor low voltage power cables will include an integral ground conductor.
- In low voltage variable frequency drive (VFD) applications, VFD rated cable will be used.
- The minimum conductor size will be #12 AWG.

Control Cable

- 600V control cable will have flame retardant EPR or flame retardant XLPE insulation rated for 90°C and the conductors will be copper.
- Jackets will be CPE or LSZH.
- The minimum size of control cables will be #14 AWG. Control cable will utilize E-2 (formerly K-2) color coding.

Instrumentation and Thermocouple Cable

- 600V instrumentation cable and 300V thermocouple cable jackets will be CPE or LSZH.
- The insulation will be flame retardant EPR or flame retardant XLPE with copper conductors for instrumentation cable, chromel-constantan (Type E), iron-constantan (Type J), or chromel-alumel (Type K) for thermocouple cables, with individual pair/triads shielded, and a tinned #18 AWG copper drain wire, with a minimum twist frequency of 1-1/2 to 2 inches.

The minimum conductor size will be #16 AWG.

6.9 Raceway

Low voltage power cables, control cables, and low-level signal instrument cables will be installed in separate raceways. Cables of like levels may be run together in conduits or trays and unlike levels will be run in separate conduits or trays. Power cable will be limited to one cable per conduit. Intermixing of circuit levels is not allowed in the same raceway, except in cable tray with appropriate barriers installed to provide separation. Redundant circuits that are critical, such as DCS fiber communications, will be routed in separate raceways.

All cable trays will be heavy duty type with a minimum load rating of NEMA 20C. The standard cable tray widths for use will be 12", 18", and 24". Minimum cable tray width will be 12". Cable trays will generally be provided where ten or more circuits of the same separation class are routed in the same direction above ground.

Power, control, and instrumentation cable trays will be hot-dipped galvanized after fabrication steel, ladder type, 6 inches deep unless otherwise noted with topmost tray provided with covers, except for cable tray in covered trench. Tray supports will have a maximum spacing of 10 feet depending upon the layout.

Conduits will be used for areas where a tray system is not feasible or economically justifiable. Conduits will also be used for routing cables from the tray system or embedded conduit to the terminal equipment. Conduits will be rigid galvanized steel and will generally be limited to 3/4, 1, 1-1/2, 2, 3, 4, 5, and 6-inch diameters. Intermediate conduit (IMC) and electrical metallic tubing will not be used. Flexible conduits will be of liquid-tight type, with PVC jacket over a galvanized steel, flexible conduit.

6.10 Lighting

For normal operation, the lighting systems provide illumination in all interior and exterior areas. During emergency or abnormal conditions, minimum lighting will be provided for personnel safety and emergency egress. The 120V AC lighting system will be served by lighting transformer in the MCC. All outdoor lighting will be corrosion resistant. The emergency lighting will be from self-contained wall mounted lighting fixtures with battery backup units. All new lighting fixtures will be of 4000K LED type.

The lighting panel will supply power to the 120V convenience receptacle circuits. Convenience receptacles rated 20A, 125 VAC will be limited to five per circuit. Duplex receptacles will be located such that 75-foot extension cords will reach.

All distribution panel breakers will be capable of being Locked Out/Tagged Out. Lighting will be designed with foot candle levels per the IESNA standard recommended lighting levels.

6.11 Grounding

A new grounding system for the hydrogen facility will be installed to include an inter-connection of buried bare copper conductors and ground rods to from a new ground grid for the system. All new structures and equipment will be connected to the ground grid. The grounding ring around equipment foundations will be approximately 3 feet from the foundation edge.

6.12 Lightning Protection

Lightning protection will be provided for structures that are not adequately shielded from direct lightning strikes by other structures. Lightning protection generally will not be required for metallic structures that are not likely to be damaged by a lightning strike, provided the structure is electrically continuous and capable of conducting lightning currents without damage. Lightning protection systems will be designed per NFPA-780 and UL 96A certified.

6.13 Motors

Motors ½ HP and less will be rated 120V, 1-phase, 60Hz. Motors more than ½ HP and up to and including 250 HP will be rated 460V, 3-phase, 60Hz. 120V and 460V motors will have a 1.15 service factor. Motor enclosure type shall be Totally Enclosed Fan Cooled (TEFC), indoors and outdoors or classified as required by the environment. Motors 25 HP and larger will be provided with 240V rated space heaters operated from a 120V power source. All motors shall comply with NEMA MG-1 and have a temperature rise of Class B and Class F insulation.

7.0. INSTRUMENTATION AND CONTROLS DESIGN BASIS

GE will provide all the required controls modifications that must be implemented in the turbine control system (TCS) required to cofire hydrogen and replace the existing Ovation control system with Mark VIe control system. New control system will have redundant communication via GSM to existing plant Ovation DCS. Additional instrumentation and analyzers may be required on the fuel delivery system at the discretion of GE. GE will also be required to evaluate the impacts to existing instruments located within the turbine enclosure to ensure conformance with any NFPA hazardous area classification changes due to the new fuel blends. Other impacts in the turbine area may include ventilation changes, gas and flame detector modifications, and fire protection system modifications.

The plant Ovation DCS will be modified to add a new controller for the control of the hydrogen storage equipment monitoring and control.

The nitrogen generator discharge pressure will be monitored via pressure transmitter with interlocks hardwired to the GE control system for hydrogen fuel operational permissive (sufficient pressure/capacity for purge) and remote monitoring. The interlocks will ensure that the combustion turbine will not operate unless sufficient nitrogen is available in the nitrogen receiver in case of an upset scenario where the turbine and blending skid would need to be purged.

The new hydrogen system will be equipped with all necessary emergency shutdown and purging instrumentation to facilitate complete system controls and safe operations.

The emergency shutdown valve(s) will be wired to two (2) pushbutton stations, one in the control room and one locally. The emergency shutdown valve(s) will have a redundant solenoid configuration for reliability. Once relays are tripped (de-energized), reset will require Operator intervention to manually reset the emergency shutdown circuit..

The Electrolyzer process containers will include gas and flame detectors and be controlled by standalone PLC control systems that will perform all necessary controls and reporting for the electrolyzer operations. This PLC control system will communicate to the plant DCS utilizing a non-redundant fiber connection for Modbus TCP/IP data communications to existing DCS utilizing existing spare communication ports and media converter. Critical control signals will be hardwired to the plant DCS.

The Hydrogen Compressor will be controlled by a standalone PLC control system that will perform all necessary controls and reporting for compressor operation.

Tube Storage Racks will have 22 control valves that will regulate blending skid pressure within a window between 310 PSIG to 400 PSIG. The control valves will be controlled from DCS located in the PDC.

Balance of plant systems include demin water supply to electrolyzers, instrument air to blending skid and hydrogen pressure regulating valves, and wastewater sump pumps. The Demin Water pumps will be controlled and operated from the DCS. Instrument air compressor and wastewater sumps will be operated from local control panels.

Local I/O will be hardwired to a new DCS I/O cabinet within the electrical PDC. This DCS I/O cabinet will be powered by the new UPS system and will communicate via extended network to the DCS room via redundant fiber optic cables.

All home-run fiber optic cables will be terminated within fiber optic patch panels. Instrumentation will be provided for the monitoring of the hydrogen production and storage system outside of the electrolyzer system. This will include hydrogen flow monitoring (supplied by GE), pressure monitoring, temperature monitoring, and the control of the hydrogen compression and storage system.

All instrumentation in the presence of hydrogen will be rated Class I, Division 2, Group B except for a 3 feet radius around venting points which will be classified as Class I, Division 1, Group B. All instrumentation on the blending skid will be rated Class I, Division 2, Groups B/C/D. Area gas and flame detection will be added in the compressor and hydrogen storage areas if deemed necessary via appropriate risk reviews.

All control valves are to be air operated with failure positions to be determined via appropriate risk reviews and process hazard analyses (PHAs). All instrumentation to be ranged to be failsafe.

8.0. CIVIL DESIGN BASIS

8.1 Existing Site Conditions

The geotechnical report and topographic survey provided by Duke shall be used as the design basis for the project. The geophysical survey provided by Duke shows all existing underground utilities and shall be referenced wherever breaking ground is necessary [HOLD].

A new berm will be located north of the new hydrogen production and storage equipment to separate the new system from the existing bermed area designed to contain fuel oil from the fuel oil tank. The new berm will create two berm containments, the northern containment designed to contain the fuel oil spill from the fuel oil tank, and the southern bermed area where the new hydrogen production and storage equipment will be located. It is not required to berm the hydrogen equipment itself, but the new berm will create a second containment around the hydrogen equipment as a byproduct. Due to stormwater concerns, a lift station will also be installed in southern containment near the hydrogen equipment to pump stormwater north to ensure there is minimal impact to stormwater flows.

HOLD:

Additional geotechnical study and borings needed for area of concern. Results from the study may impact site layout and design.

8.2 Permitting

It is anticipated that the site will disturb in excess of one (1) acre, and therefore a SWPPP (Stormwater Pollution Prevention Plan) will be required. Stormwater quantity and quality controls may be needed to meet the Volusia County stormwater management standards or the St. John's River Water Management District requirements. Permitting and stormwater management requirements will be determined during later phases of the project.

8.3 Erosion Prevention and Sediment Control

Erosion prevention and sediment control practices used shall meet the requirements of the latest edition of the Florida Erosion and Sediment Control Manual. It is anticipated that the site will utilize rock construction entrances, silt fencing, and rolled erosion control products during construction. Any disturbed areas will be either stabilized with stone surfacing or pavement or be revegetated with an FDOT-approved grass mix.

8.4 Site Grading and Drainage

The new hydrogen production and storage system compound is located in the vicinity of an old storage tank location that has been removed. The existing site is graded to drain to a ditch system around the perimeter of the old tank area.

The overall existing drainage pattern will not be modified as part of the project. After construction, stormwater will be pumped through the new berm into the oil tank containment area, which discharges to the perimeter ditches. Localized grading of the hydrogen production and storage system may be performed as necessary to provide a level area for the tanks and to ensure drainage toward the new lift station.

8.5 Site Surfacing

Site surfacing shall be in accordance with the relevant Duke standards. It is anticipated that the hydrogen production and storage system will be surfaced with crushed stone area surfacing. Any materials used for stone or asphalt surfacing shall meet FDOT Standard Specifications for Road and Bridge Construction requirements.

8.6 Roads

Roads shall be designed to accommodate the largest vehicle anticipated during construction or operation to enter the hydrogen production and storage system. The road access shall be a minimum of 10 ft wide ft wide and connect to the existing asphalt paved plant access road. The design life for any new roads shall be a minimum of 20 years.

At a minimum, HS-20 loading is assumed for vehicle access. Roads shall be crowned to provide drainage to the adjacent grass vegetated areas.

8.7 Fencing

Any new required fencing shall meet the requirements of Duke Energy specifications.

9.0. STRUCTURAL DESIGN BASIS

9.1 Material

All structures shall be designed and constructed using either standard steel shapes or tapered tubular polygonal shapes. Table 9-1 outlines the materials to be used for structural components.

- All detailing, shop, and field workmanship to be done in accordance with AISC "Manual of Steel Construction" Latest Edition
- All steel structure members shall be cleaned prior to finishing.
- Coating process shall be an electrostatically applied polyester powder with a final baked on average thickness between 2.0 and 4.0 mils.
- Finish shall have a minimum pencil hardness of 2H as tested per ASTM D3363.
- Finish shall pass the ASTM B117 salt spray test for a minimum of 1000 hours.

Table 9-1 – Materials Table

Structural Component	Material
Structural steel wide flange	ASTM A992
Structural steel tees	ASTM A992
Structural steel channels	ASTM A36
Structural steel angles	ASTM A36, ASTM A572 Grade 50, or ASTM A529
Hollow structural sections (HSS)	ASTM A500 Grade C
Structural pipe, posts, and rails	ASTM A500 Grade C or ASTM A53 Grade B
Base plates and shear bars	ASTM A572 Grade 50
Welds	E70XX electrodes
Bar Grating	Fabricated from welding quality steel equal to ASTM A1011 for bearing bars and ASTM A510 for cross bars. All bar grating shall have 3/8" bearing bars spaced at 1 3/16" on center with cross bars at 4" on center.
Reinforced Concrete	Normal weight (150 pcf) Minimum Strength $f_c' = 4{,}500$ psi at 28 days Water cement ratio = 0.45 Modulus of Elasticity, $E_c = 3824$ ksi
Reinforcing Steel	ASTM A615 Grade 60
Cast-in-Place Anchor Rods	ASTM F1554 Grade 36
Post-Installed Anchor Rods	HILTI HAS-E Threaded Rods (installed using HILTI HIT HY-200 or RE-500 v3)
Grout	Non-Shrink grout per ASTM C1107 Grades B or C Minimum Strength $f_c' = 5{,}000$ psi at 28 days

9.2 **Design**

Steel structures and concrete foundations shall be designed in accordance with:

- 2020 Florida Building Code, 7th Edition
- 2018 International Building Code
- ASCE 7-16 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- ACI 318-14 – Building Code Requirements for Structural Concrete
- AISC 360-16 – Specification for Structural Steel Buildings

9.3 **Structure Design Loads**

Load combinations shall be in accordance with ASCE 7. Structures shall be designed for all applicable dead, live, wind, seismic, equipment, service and thermal loads. The following loading conditions shall be used to analyze and design the structure.

9.3.1 **Dead Load**

Dead load is defined as the weight of the structure and equipment. The following material densities will be considered in the calculation of the dead load of the structures:

Steel..490 pcf
Concrete (including rebar) ....150 pcf

9.3.2 **Live Load**

The following live loads used in design are as follows:

Floor Live Loads (Lf)
Access/service platforms & galleries...................100 psf
Roof Live Loads (Lr)
Pre-Engineered Building Enclosures ....20 psf
Soil Surcharge Loads (Lg)
Normal Loading Case ....500 psf
Construction Loading Case.................................1000 psf
Equipment Live Loads (Le)
Equipment contents and/or dynamic load effects provided by vendor.

9.3.3 **Wind**

Wind loads shall be determined in accordance with ASCE 7-16 with the parameters listed below:

Risk Category..	III	(ASCE 7-16, Table 1.5-1)
Basic Wind Speed	V = 142 mph	(ASCE 7-16, Figure 26.5-1C)
Wind Directionality Factor	$K_d = 0.85$	(ASCE 7-16, Table 26.6-1)
Wind Exposure Category	C	(ASCE 7-16, Section 26.7)
Topographic Factor..	$K_{zt} = 1.0$	(ASCE 7-16, Section 26.8)

9.3.4 **Seismic**

Seismic loads shall be determined in accordance with ASCE 7-16 with the parameters listed below:

Risk Category..	III	(ASCE 7-16, Table 1.5-1)
Seismic Importance Factor..................................	$I_e = 1.25$	(ASCE 7-16, Table 1.5-2)

Site Class..D		(See note below)
Mapped MCE_R (short period) ....$S_s = 0.066g$		(ASCE 7 Online Hazard Tool)
Mapped MCE_e (1 sec period)............................$S_1 = 0.036g$		(ASCE 7 Online Hazard Tool)
Adjusted MCE_R (short period)..........................$S_{MS} = 0.106g$		(ASCE 7-16, Equation 11.4-1)
Adjusted MCE_R (1 sec period)..........................$S_{M1} = 0.086g$		(ASCE 7-16, Equation 11.4-2)
Design MCE_e (short period)..............................$S_{DS} = 0.070g$		(ASCE 7-16, Equation 11.4-3)
Design MCE_R (1 sec period)..............................$S_{D1} = 0.057g$		(ASCE 7-16, Equation 11.4-4)
Seismic Design Category ....A		(ASCE 7-16, Tables 11.6-1&2)

Note: Because the site-specific geotechnical report is currently unavailable, the soil site class is taken as the default which is Site Class D per ASCE 7-16 Section 20.1. This value and the subsequent seismic parameters will be updated once further information becomes available.

9.3.5 Snow Load

Snow loads shall be determined in accordance with ASCE 7-16 with the parameters listed below:

Ground Snow Load ....$p_g = 0$ psf	(ASCE 7-16, Figure 7.2-1)
Snow Importance Factor ....$I_s = 1.10$	(ASCE 7-16, Table 1.5-2)

9.4 Structure Deflections

The maximum allowable deflections for structural steel elements, where L is the span for the element, are given in Table 1604.3 of IBC 2018.

Foundation settlement will be limited to 1" total settlement and ½" differential settlement. Parameters for determining foundation settlement will be based on the geotechnical report data, which is yet to be received.

Where structures support equipment with vendor specified deflection limits that are more stringent that those listed above, the more stringent deflection limit shall govern the design of the structure.

Attachment 1:

Duke Tagging Procedure

DUKE ENERGY.

DeBary Hydrogen Production and Storage Project
Component Naming for P&IDs, Rev 3

Component Naming Format	
Equipment	XXXXX - XXXX - ### X
Process System Code	
Equipment Tag Designation (Table 3)	
Tag Number	
Parallel Designator (A, B, C, etc., if required)	

Tag numbers reset for each Equipment Designation
Example: DEMN-PMP-600, WWT-PMP-601, HY-TNK-001, HY-TNK-002

Locate equipment information at top and bottom (pumps) of the drawing.
Equipment information should include at minimum: Name and Description, Size, Design (Pressure & Temperature), and Material. For Pumps and Compressors, include: Name and Description, Capacity, Differential Pressure, Motor (size), Material

Examples:

DEMN-PMP-600 A/B	DEMN-TNK-600
DEMINERALIZED WATER PUMP	DEMINERALIZED WATER BLADDER TANK
CAPACITY: # GPM	SIZE: # DIA x # T-T
DIFF. PRESS: ## PSIG	DESIGN: # PSIG, # F
MOTOR: # HP	MATERIAL: CS
MATERIAL: CS	

Valves and Instruments	XXXXX - XXXX - ### X
Process System Code	
Valve/Instrument Tag Designation	
Tag Number	
Parallel Designator (A, B, C, etc., if required)	

Tag numbers reset for each system. See available tag numbers in Table 2.
Do not restart valve tag numbers for different valve designations
Example: HY-ISV-001, HY-MCV-002, HY-FCV-003

Typically, associated instruments with or without a valve have the same tag number.
Example: HY-FE-003, HY-FT-003, HY-FI-003, and HY-FCV-003
Should we drop the System Code for Instruments for simplicity on P&D's?

Pipe Lines	XX - XXXX - XXX - ### X
Pipe Size (in)	
Class Designation Code (Pipe Spec - material & class)	
Insulation and Tracing Code, etc.	
Tag Number	
Parallel Designator (A, B, C, etc., if required)	

Pipe Class Specification and Insulation by the ESP (External Service Provider)

Naming based on TagsPro and
Control System Database Tag Naming Standard (FHG-ENG-NA-STND-IC-0006)
Note: Deviations made to follow Debary conventions

Table 1 - Unit Designations

Units	Description
BOP	Balance of Plant (Common)
P01	
P02	
P03	
P04	
P05	
P06	
P07	
P08	
P09	
P10	

The Hydrogen Production and Storage area is considered to be part of the BOP (Common) Unit.

Table 2 - Process System Codes
Red is new

System	Description	Numbers Available for Use: Valves/Instruments	Numbers Available for Use: Equipment/Lines
2815	FUEL PURGE		
AA	ATOMIZING AIR		
CHFD	CHEMICAL FEED		
CWS	COOLING WATER		
DEMN	DEMIN WATER	600-700	600-700
FG	FUEL GAS	600-700	600-700
FP	FIRE PROTECTION		
GT	DRAINS		
GTHYD	HYDRAULIC		
GTLO	LUBE OIL		
HY	HYDROGEN	001-	001-
IAIR	INSTRUMENT AIR	600-700	600-700
LFS	Liquid Fuel		
NT	NITROGEN △2	001-	001-
PA	PLANT AIR	600-700	600-700
SW	SERVICE WATER		
STW	STORM WATER △3	001-	001-
WINJ	WATER INJECTION		
WTRT	WATER TREATMENT		
WTRW	WATER WASH		
WWT	WASTE WATER	600-700	600-700

Table 3 - Equipment

Designation	Description
BLW	Blower
CMP	Compressor
DRY	Dryer
FAN	Fan
FLT	Filter
HTR	Heater
HTX	Heat Exchanger
MIX	Mixer
PMP	Pumps
SKD	Skid, Equipment
SMP	Sump
STR	Strainer
TNK	Tank, Reservoir and Vessel

Table 4 - Valves

Designation	Description
3WV	3-Way Valve
ABV	Air Block Valve
ACV	Air Control Valve
ARV	Auto Recirc Valve
BPV	Bypass Valve
CHV	Check Valve
CRE	Unloader Valve
DLV	Deluge Valve (Fire Protection)
DV	Drain Valve
FCV	Flow Control Valve
HCV	Hydraulic Control Valve
HV	Hand Valve
ISV	Isolation Valve*
LCV	Level Control Valve
MBV	Motor Block Valve
MCV	Sample/Purge Valve*
MOV	Motor Operated Valve
PCV	Pressure Control Valve
PRV	Pressure Relief Valve*
SOV	Solenoid Valve
SRV	Safety/Power/Relief Valve
STV	Stop Valve
TCV	Temperature Control Valve
THV	Throttle Valve*
VLV	Generic Valve
VV	Vent Valve

Notes:
1) * Deviation from Control System Standard
2) Orange shaded were validated with TagsPro
3) Project Team to consider adding ESV Emergency Stop Valve to Table 4.
4) ESP has a legend sheet for all symbols included in the drawing package, for both mechanical and electrical.
5) ESP to show pipe flow direction arrows and valve normal operating position as shown below.

LEGEND:
Normally Closed
Normally Open

Table 5 - Instrumentation & Control

Designation	Description
DSK	Diaphragm/Disk, Rupture
ESS	Emergency Stop Switch
"X" IT	Indicating Transmitter
"XX"L	Low
"XX"LL	Low Low
"XX"H	High
"XX"HH	High High
"XX"C	Closed
"XX"O	Open
RO	Restrictive Orifice
PDI	Pressure Differential Indicator
PDS	Pressure Differential Switch
PDSH	Pressure Differential Switch High
PDSL	Pressure Differential Switch Low
PDT	Pressure Differential Transmitter
PDIT	Pressure Differential Indicating Transmitter
SEL	Selector

"X" Device Designation (Table 6)

Table 6 - Instrumentation

Device Instrumentation Tag Designations

DEVICE INSTRUMENT TAG DESIGNATIONS / Based on ANSI / ISA S5.1-1984 (R1992)

SECOND & SUCCEEDING LETTERS INSTRUMENT FUNCTION

FIRST LETTER VARIABLE (MEASURED OR INITIATING)	A - ALARM	C - CONTROLLER	E - PRIMARY ELEMENT	G - GLASS	I - INDICATOR	K - CONTROL STATION MAN/AUTO (WITHOUT CONTROL)	L - LIGHT	Q - INTEGRATOR	R - RECORDER/CONTINUOUS PEN	S - SWITCH	T - TRANSMITTER	U - MULTIFUNCTION (2)	V - VALVE	W - WELL	X - SPECIAL (3)	Y - RELAY/SIGNAL CONVERTER COMPUTING ETC.	Z - POWER POSITION (EXCEPT VALVE)
A - ANALYSIS (1)	-	AC	AE	-	AI	AK	AL	-	AR	AS	AT	-	-	-	-	AY	AZ
B - BURNER-FLAME	BA	BC	BE	-	BI	-	BL	-	BR	BS	BT	-	-	-	-	BY	-
C - CONDUCTIVITY	CA	CC	CE	-	CI	-	CL	-	CR	CS	CT	-	-	-	-	CY	-
D - DENSITY	DA	DC	DE	-	DI	DK	DL	-	DR	DS	DT	-	-	-	-	DY	-
E - VOLTAGE	EA	EC	EE	-	EI	EK	EL	-	ER	ES	ET	-	-	-	-	EY	-
F - FLOW	FA	FC	FE	FG	FI	FK	FL	FQ	FR	FS	FT	-	-	-	-	FY	FZ
H - HAND (MANUAL)	HA	HC	-	-	-	HK	-	-	-	HS	-	-	-	-	-	HY	HZ
I - CURRENT (ELEC.)	IA	IC	IE	-	II	-	IL	-	IR	IS	IT	-	-	-	-	IY	-
J - POWER (KW) (ELEC.)	JA	JC			JI		JL	-	JR	JS	-	-	-	-	-	JY	-
K - TIME	KA	KC	-	-	KI	KK	KL	KQ	KR	KS	-	-	-	-	-	KY	KZ
L - LEVEL (LIQ.-SOL.)	LA	LC	-	LG	LI	LK	LL	-	LR	LS	LT	-	-	-	-	LY	LZ
M - MOISTURE (HUMIDITY)	MA	MC	ME	-	MI	MK	ML	-	MR	MS	MT	-	-	-	-	MY	-
N - NEUTRON FLUX	NA	NC	NE	-	NI	NK	NL	-	NR	NS	NT	-	-	-	-	NY	-
P - PRESSURE OR VACUUM	PA	PC	PE	-	PI	PK	PL	-	PR	PS	PT	-	-	-	-	PY	PZ
R - RADIOACTIVITY	RA	RC	RE	-	RI	RK	RL	-	RR	RS	RT	-	-	RW	-	RY	-
S - SPEED OR FREQUENCY / SOLENOID	SA	SC	SE	-	SI	SK	SL	-	SR	SS	ST	-	SV	-	-	SY	SZ
T - TEMPERATURE	TA	TC	TE	-	TI	TK	TL	-	TR	TS	TT	-	-	TW	-	TY	TZ
U - MULTIVARIABLE (2)	-	-	-	-	-	-	-	-	-	-	-	UU	-	-	-	-	-
V - VIBRATION	VA	VC	VE	-	VI	VK	VL	-	VR	VS	VT	-	-	-	-	VY	-
W - WEIGHT	WA	-	WE	-	WI	-	WL	-	WR	WS	WT	-	-	-	-	WY	-
X - SPECIAL (3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y - STRAIN	YA	-	YE	-	YI	-	YL	-	YR	YS	YT	-	-	-	-	XY	-
Z - POSITION	ZA	ZC	-	-	ZI	ZK	ZL	-	ZR	ZS	ZT	-	-	-	-	ZY	-

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