"BUILDING INTEGRATED PHOTOVOLTAICS – FROM BEST PRACTICE EXAMPLES TO LARGE-SCALE MARKET PENETRATION"

ONYX SOLAR ENERGY S.L. Spain

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Senior Engineer & Business Development

EU PVSEC
European PV Solar Energy Conference and Exhibition

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Solar architecture is not a fashion, it is **survival.**

Sir Norman Foster

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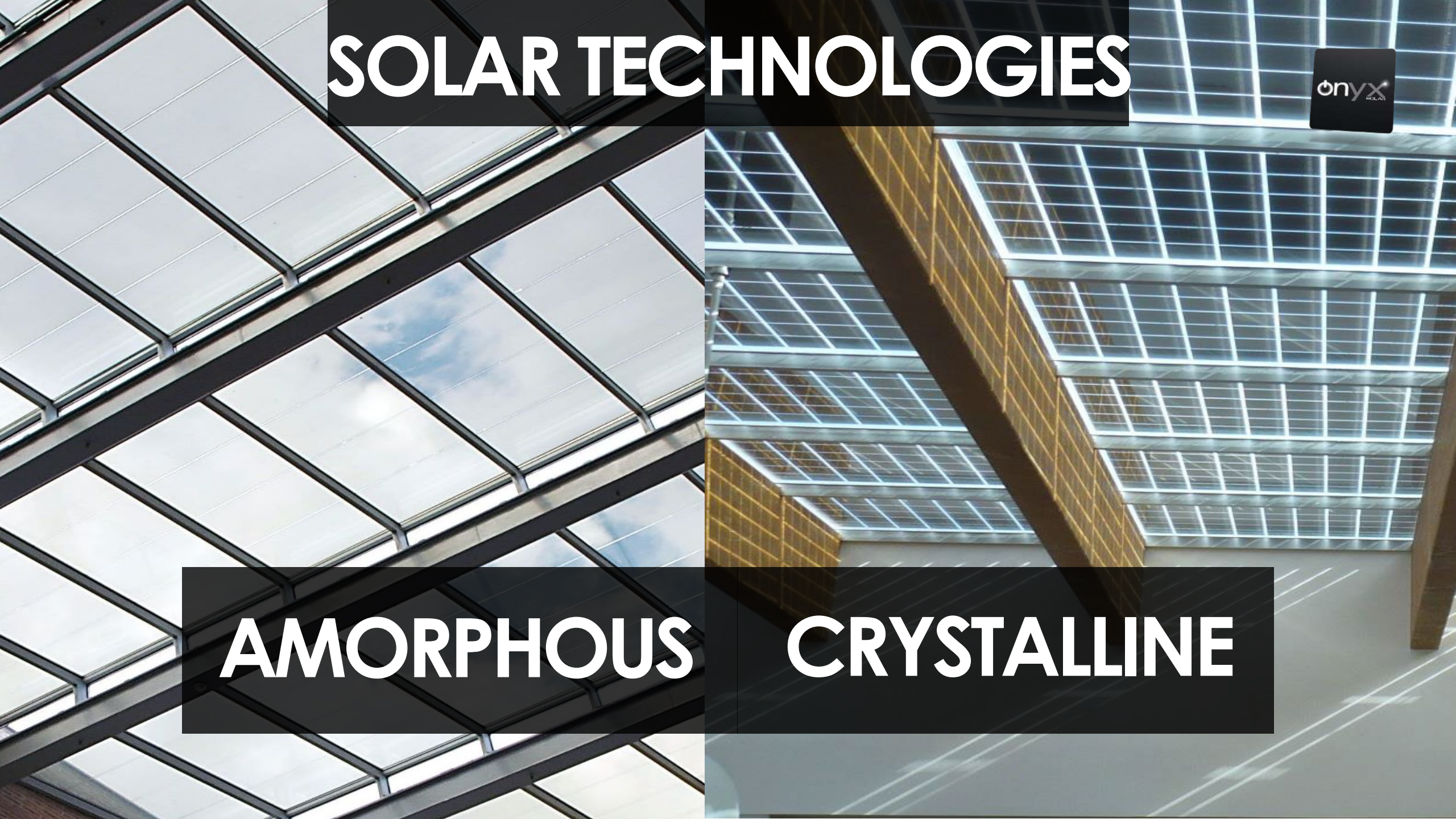
1. ONYX SOLAR: ABOUT

- Year of Incorporation: **2009**
- Ownership: **Privately held. VC on board**
- Headquarters: **Avila, Spain**
- Offices: **New York & Beijing**
- Fabrication Plant: **Avila, Spain**
- Annual Production Capacity: **250.000 Sqm**
- Tech. Manufactured: **Amorphous (a-Si) and Crystalline Silicone (c-Si)**
- Projects completed: **+250 worldwide**.

https://www.onyxsolar.com/all-you-need

SOLAR TECHNOLOGIES



AMORPHOUS

CRYSTALLINE

AMORPHOUS

Coating over a layer of flat glass (CVD)

Visual Light Tr: Dark, 10, 20, 30%

Efficiency 5% - 10%

Greater **energy production** (kWh) at the same installed power (kWp)

Better behavior under the presence of shadows / overcast (tilt, orientation)

Low temperature coefficient – performs well under high temperature

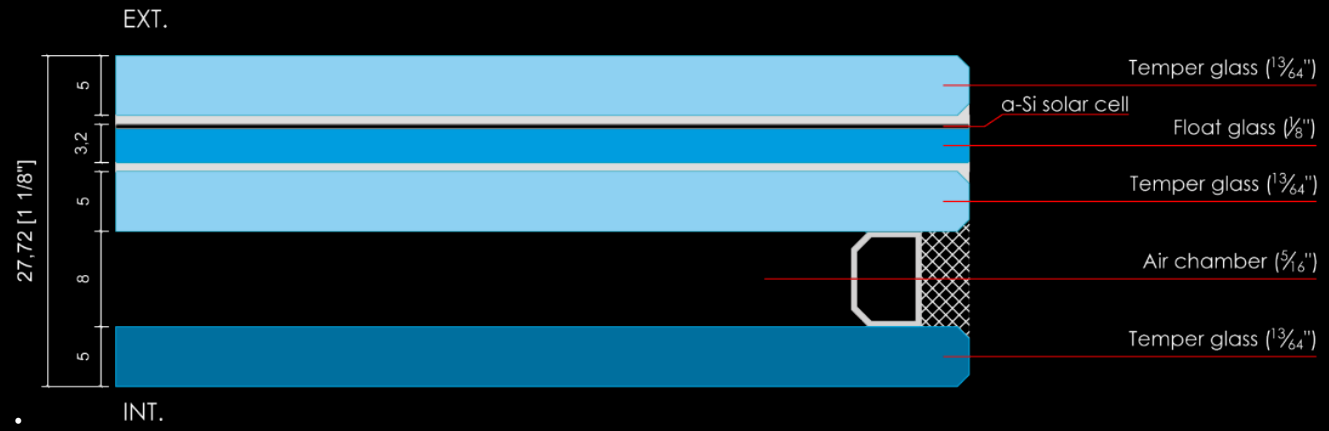
Unobstructed views

ADD-ONS

By add-ons we refer to other configurations for the photovoltaic glass that, depending on the performance desired for the project, may be required.

Spacers are a typical add-on to improve the U-value of the PV glass unit; counting on an double pane unit and considering the coatings applied, the photovoltaic glass can reach U-values as low as **0.13 BTU/h*Ft2*F°**.

Typical spacer thicknesses are ¼", ½" and 10/16", depending on the insulation required. Air and Argon gas fills are commonly requested.



Picture on the left shows a typical amorphous Silicon double glazing configuration, as a reference.

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2. ONYX SOLAR APPROACH FOR BIPV

Architectural glass which besides providing the building with the same passive properties as a conventional glazing, it also **generates free electricity** from the sun.
It is therefore, the **only building material** available in the market that provides your building a **return on the investment**.

ARCHITECTURAL GLASS THAT GENERATES ELECTRICITY

- MATCHES THE ARCHITECTURAL GLASS SPECIFICATIONS
- ENVIROMENTAL BENEFITS: AVOIDING CO2 EMISSIONS
- ECONOMICAL BENEFITS: ENERGY GENERATION

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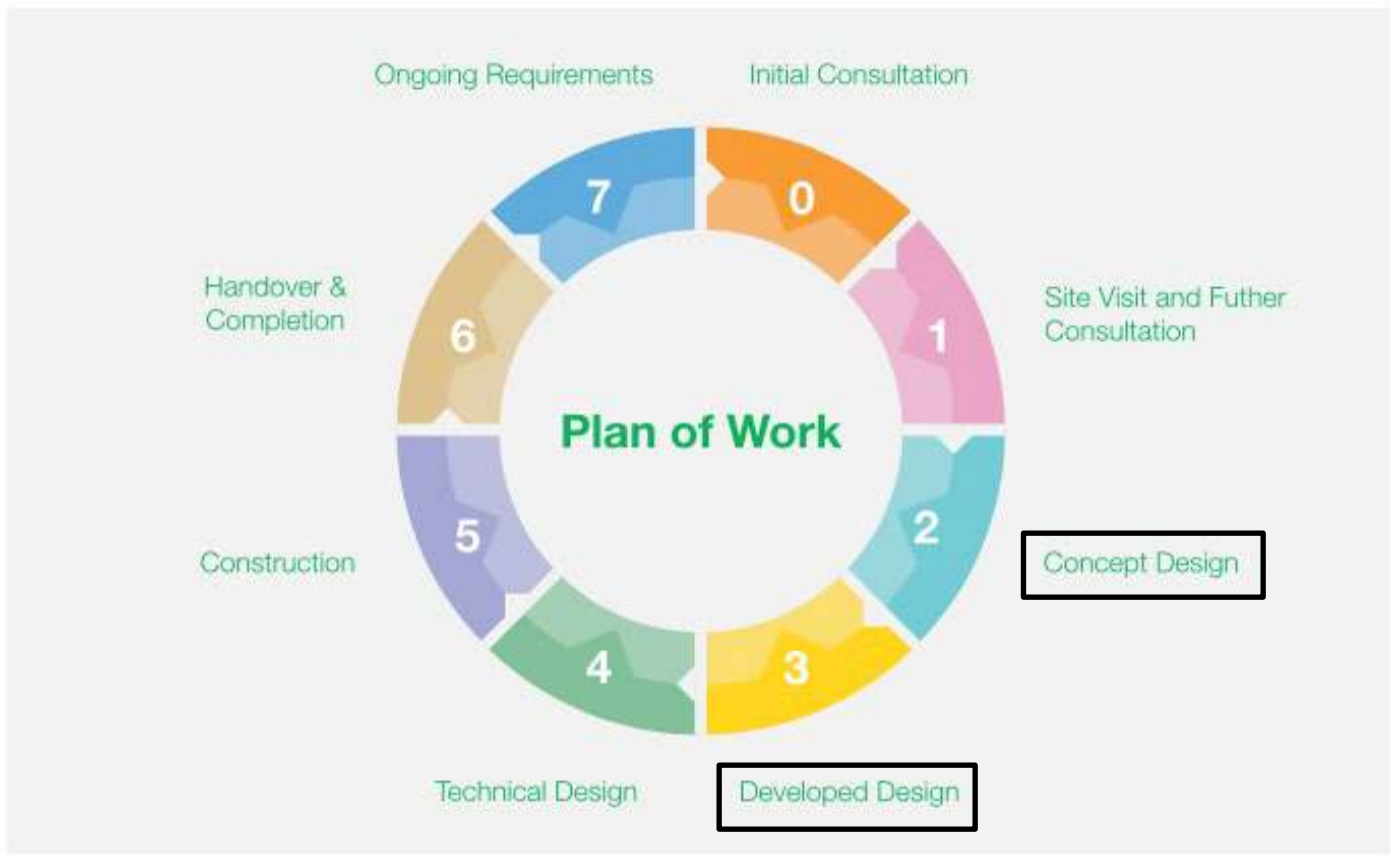
2. ONYX SOLAR APPROACH FOR BIPV



ORIGINAL SCHEME - RIBA PLAN OF WORK 2020

Onyx Solar
BIPV Consultancy Services at design phases:

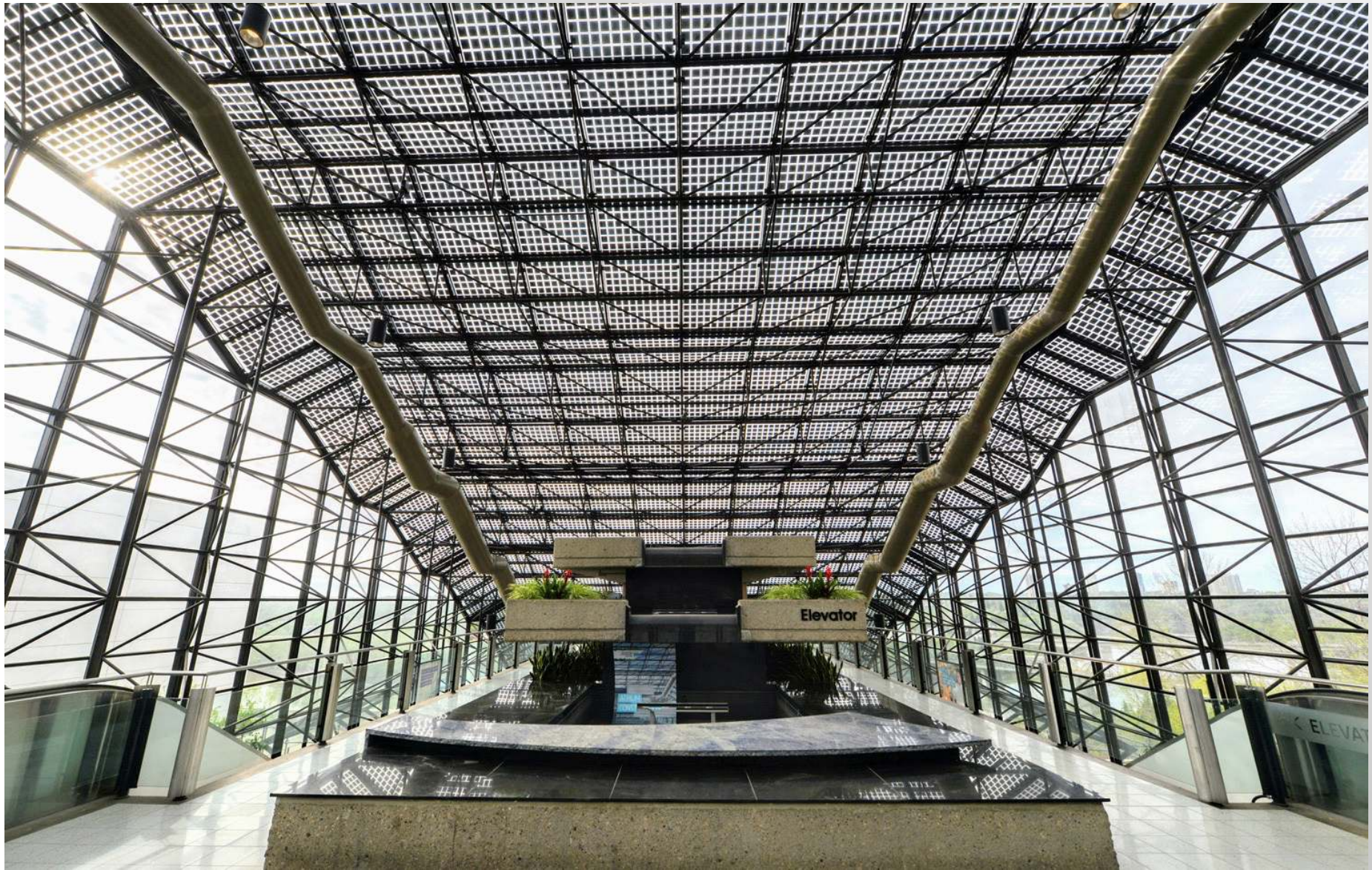
- Architectural drawing and project requirement study to provide best BIPV option for the construction project
- Close collaboration with design team.

3. CASE STUDY: EDMONTON CONVENTION CENTER, CANADA

Project Data:

- Atrium Skylight replacement with IGU PV GLASS
- Area of integration: 1,600 sqm
- Technology: mono-crystalline silicon
- Installed power: 160 kWp
- Estimated Energy Generation: 227,000 kWh/year
- Owner: ECC, City of Edmonton
- Architecture: DIALOG
- General Contractor: Bird Construction Company
- Glazing Contractor: **Flynn Canada Ltd.**
- PV Consultant: **Howell Mayhew Engineering, Inc.**

3. CASE STUDY: EDMONTON CONVENTION



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3. CASE STUDY: EDMONTON CONVENTION

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BIPV Project Schedule:

- Consultancy to the architectural design (DIALOG Architects and PV Consultant) during conceptual and developed design: **2015 - 2016**
- PV glass and PV system details during tendering phase and technical design (Glazing Contractor and PV Consultant): **2018**
- PV glass shop drawings and supply: **2019**

Main Challenges:

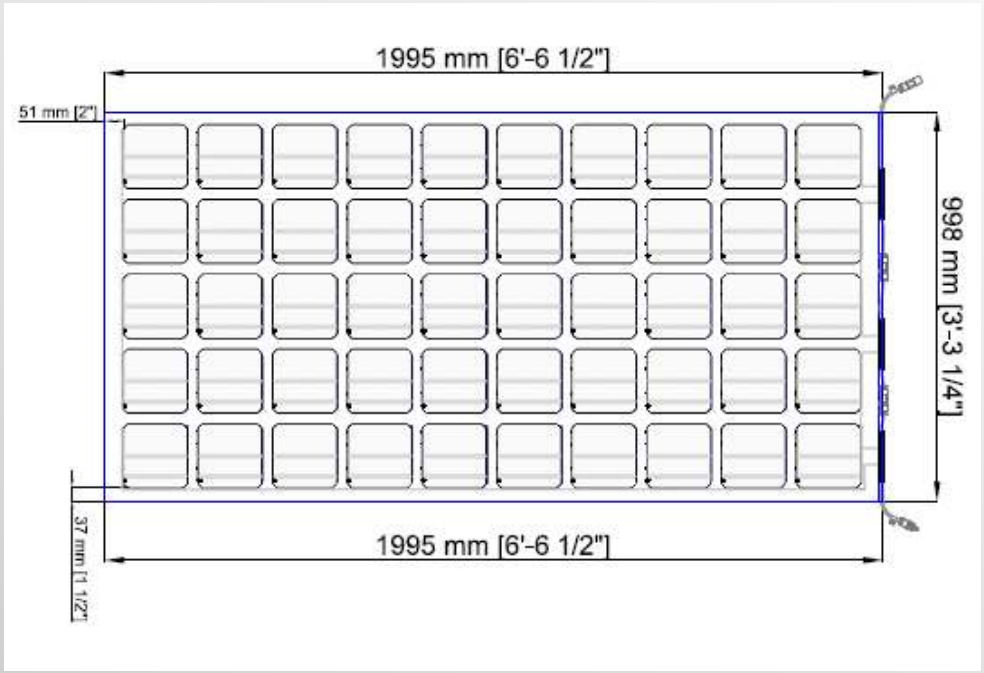
1. Coordination in detail design with all stakeholders: Consultant, Glazing Contractor and Electrical Contractor
2. Shop drawings, manufacturing and project management with 126 diferents type of units for 700 total PV glass units.

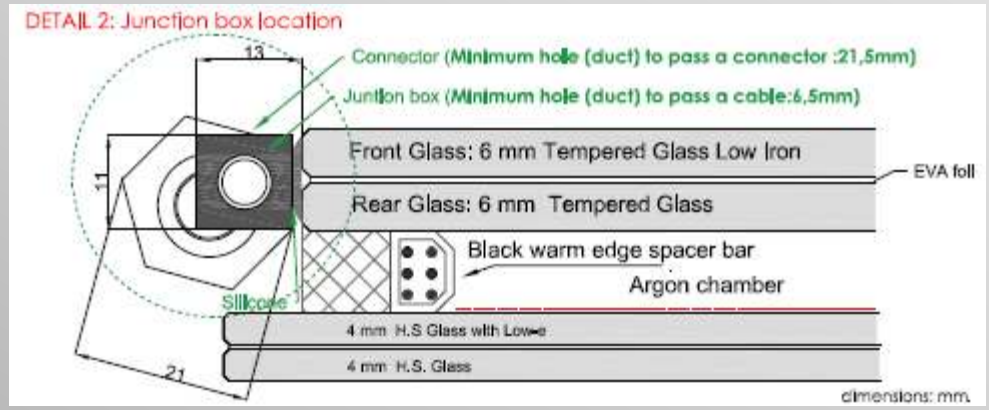
TYPICAL PV GLASS DATA SHEET

PHOTOVOLTAIC GLASS TYPE.07	1995 x 998 6" Mono	Crystalline
Electrical data test conditions (STC)		
Nominal peak power	238	P_{mpp} (Wp)
Open-circuit voltage	33	V_{oc} (V)
Short-circuit current	9.09	I_{sc} (A)
Voltage at nominal power	28	V_{mpp} (V)
Current at nominal power	8.54	I_{mpp} (A)
Power tolerance not to exceed	±10	%
STC: 1000 w/m², AM 1.5 and a cell temperature of 25°C, stabilized module state.		
Mechanical description		
Length	1995	mm
Width	998	mm
Thickness	32.56	mm
Surface area	1.99	sqm
Weight	100	Kgs
Cell type	6" Mono	Crystalline
No PV cells / Transparency degree	50	42%
Front Glass	6 mm	Tempered Glass Low-Iron
Rear Glass	6 mm	Tempered Glass
Gas Spacer	10 mm	Argon Chamber
Inner Glass	4 mm	HS Low-e Glass
Inner Glass	4 mm	HS Glass
Thickness encapsulation	1,80 mm	EVA Foils
Category / Color code		
Junction Box		
Protection	IP65	
Wiring Section	2,5 mm² or 4,0 mm²	
Limits		
Maximum system voltage	1000	Vsys (V)
Operating module temperature	-40...+85	°C
Temperature Coefficients		
Temperature Coefficient of Pmpp	-0,451	%/°C
Temperature Coefficient of Voc	-0,361	%/°C
Temperature Coefficient of Isc	+0,08	%/°C

* All technical specifications are subject to change without notice by Onyx Solar

** Dimensions as per inner glass dimensions in shop-drawings





TYPICAL PV GLASS DATA SHEET

PHOTOVOLTAIC GLASS TYPE A1	2377 x 1130 6" Mono	Crystalline
Electrical data test conditions (STC)		
Nominal peak power	286	P_{mpp} (Wp)
Open-circuit voltage	40	V_{oc} (V)
Short-circuit current	9.09	I_{sc} (A)
Voltage at nominal power	33	V_{mpp} (V)
Current at nominal power	8.54	I_{mpp} (A)
Power tolerance not to exceed	±10	%
STC: 1000 w/m², AM 1.5 and a cell temperature of 25°C, stabilized module state.		
Mechanical description		
Length	2377	mm
Width	1130	mm
Thickness	32.56	mm
Surface area	2.35	sqm
Weight	118	Kgs
Cell type	6" Mono	Crystalline
No PV cells / Transparency degree	60	41%
Front Glass	6 mm	Tempered Glass Low-Iron
Rear Glass	6 mm	Tempered Glass
Gas Spacer	10 mm	Argon Chamber
Inner Glass	4 mm	HS Low-e Glass
Inner Glass	4 mm	HS Glass
Thickness encapsulation	1,80 mm	EVA Foils
Category / Color code		
Junction Box		
Protection	IP65	
Wiring Section	2,5 mm² or 4,0 mm²	
Limits		
Maximum system voltage	1000	Vsys (V)
Operating module temperature	-40...+85	°C
Temperature Coefficients		
Temperature Coefficient of Pmpp	-0,451	%/°C
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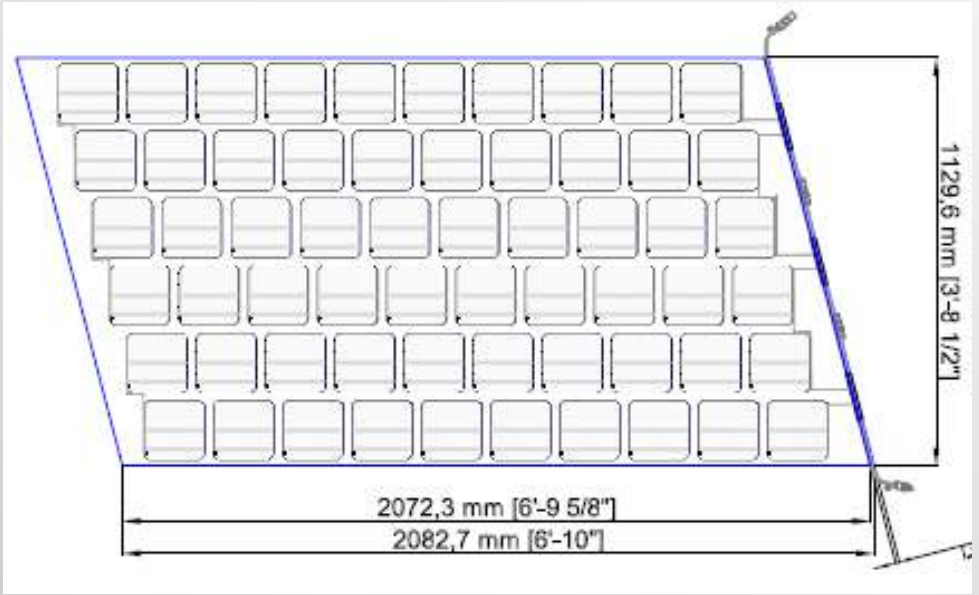
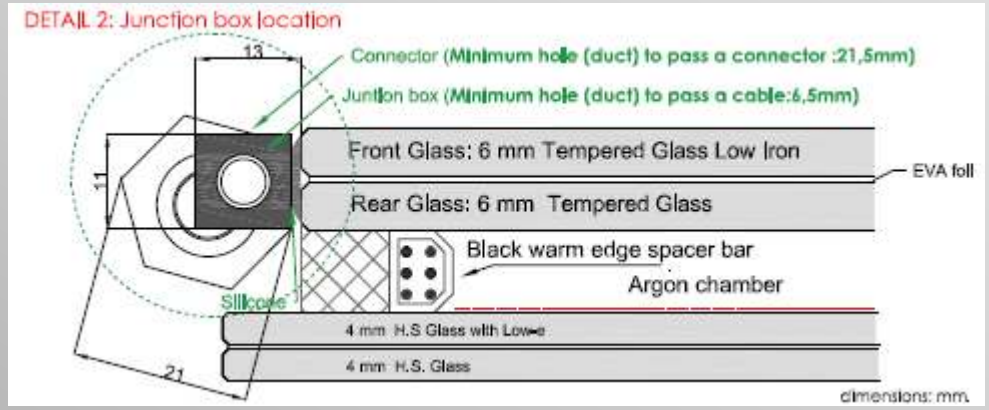
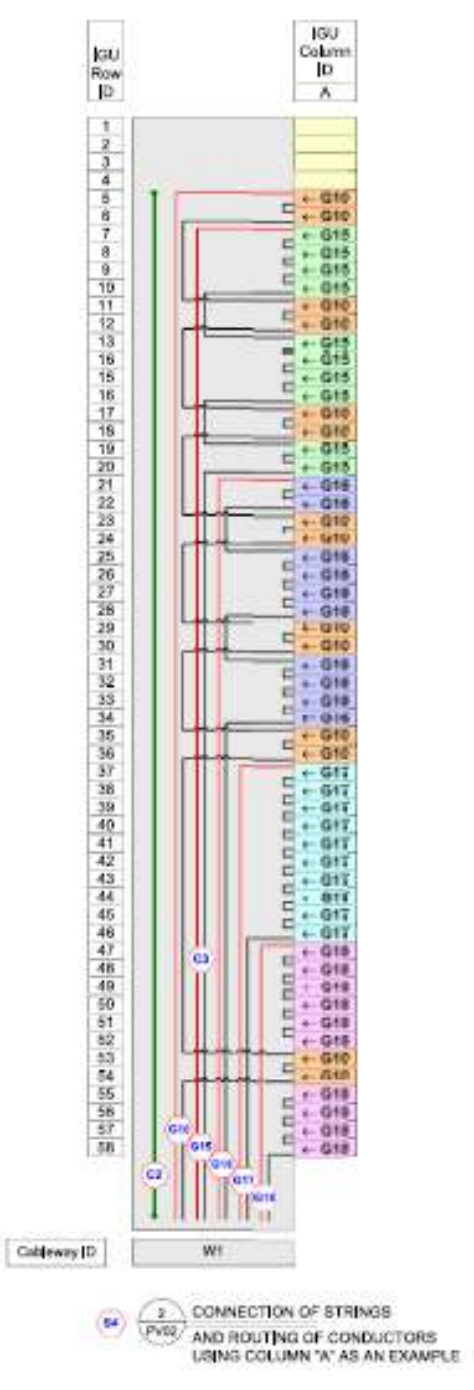
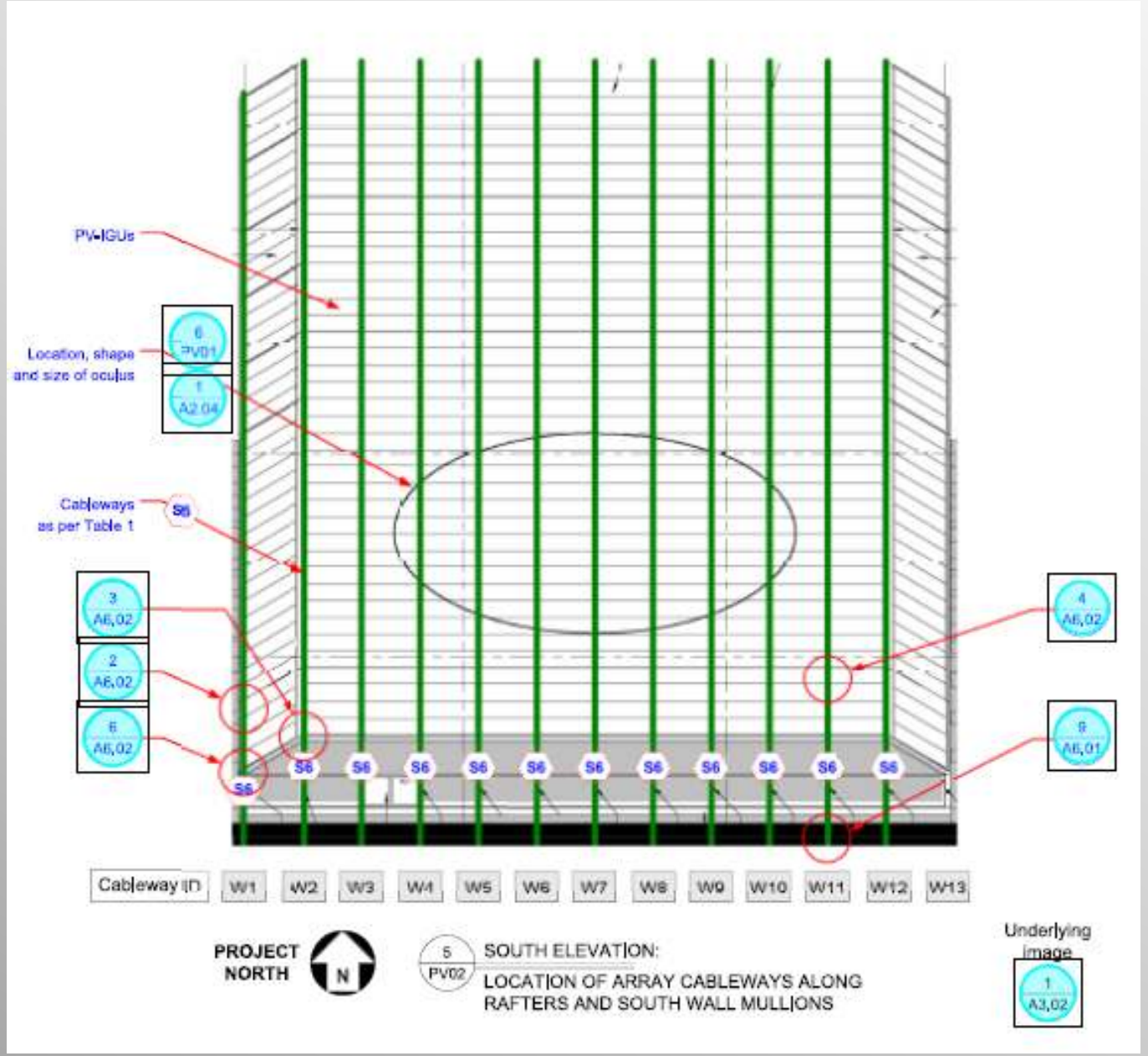




WIRING PLANS – STRING INTERCONNECTION





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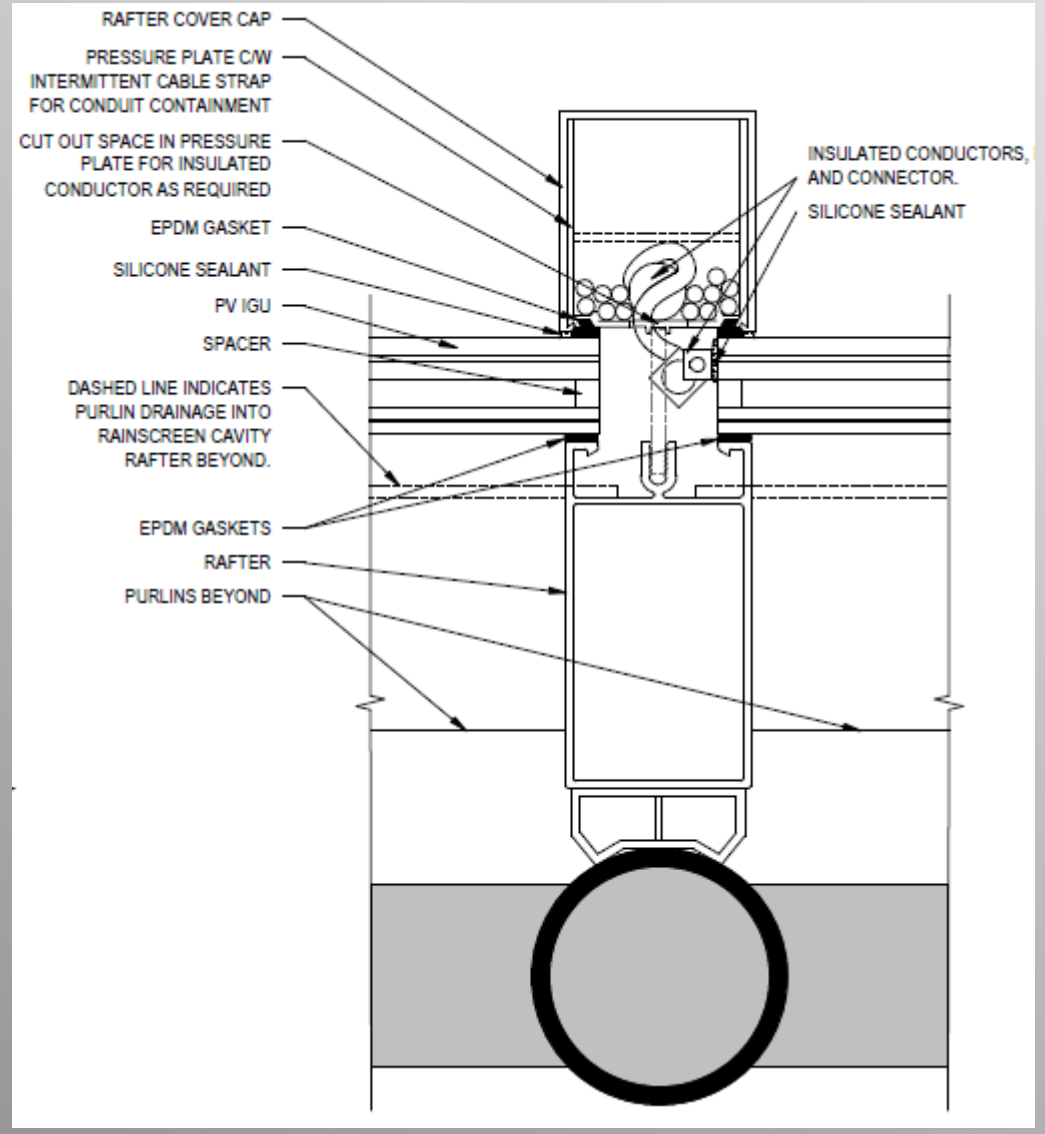
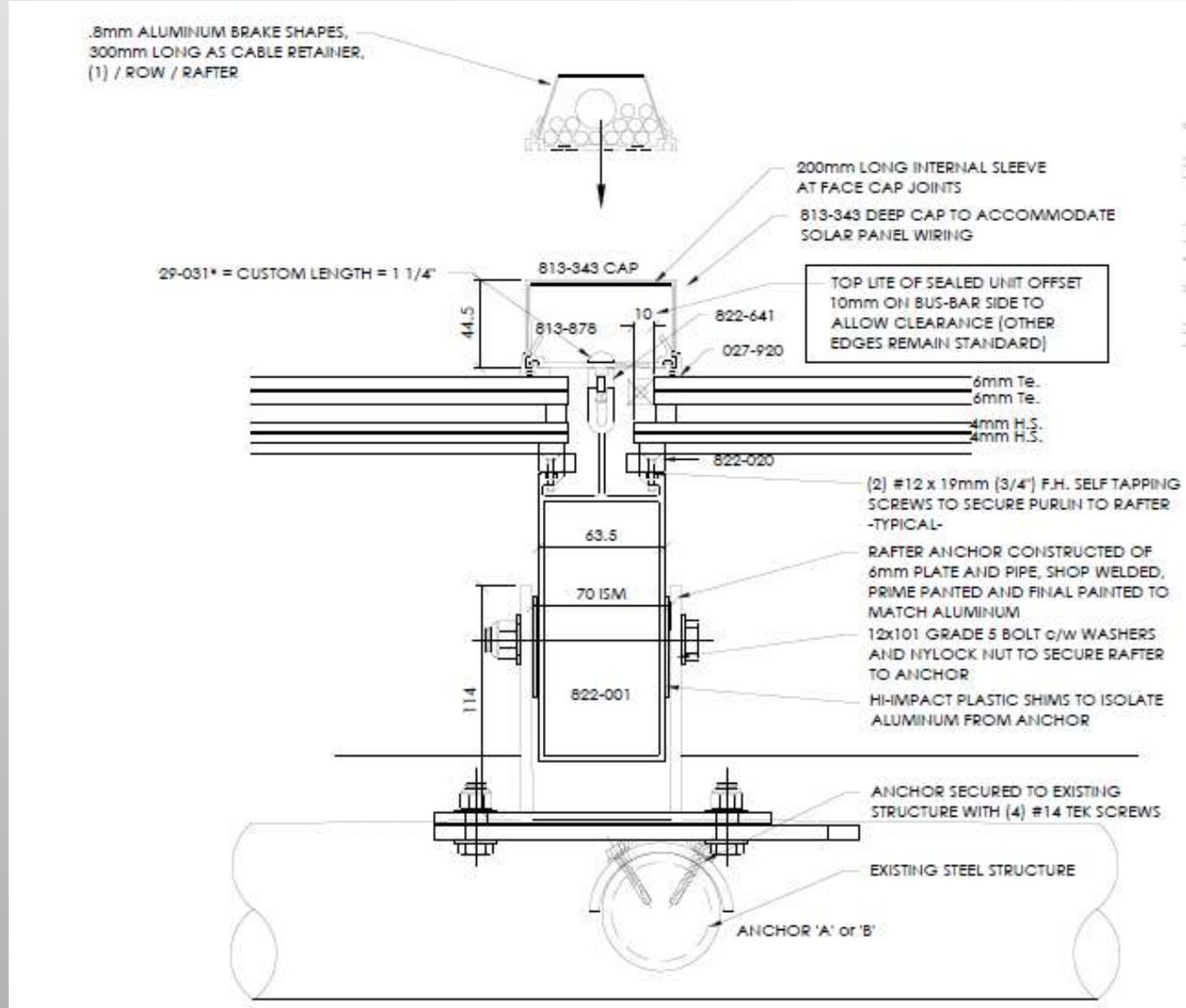
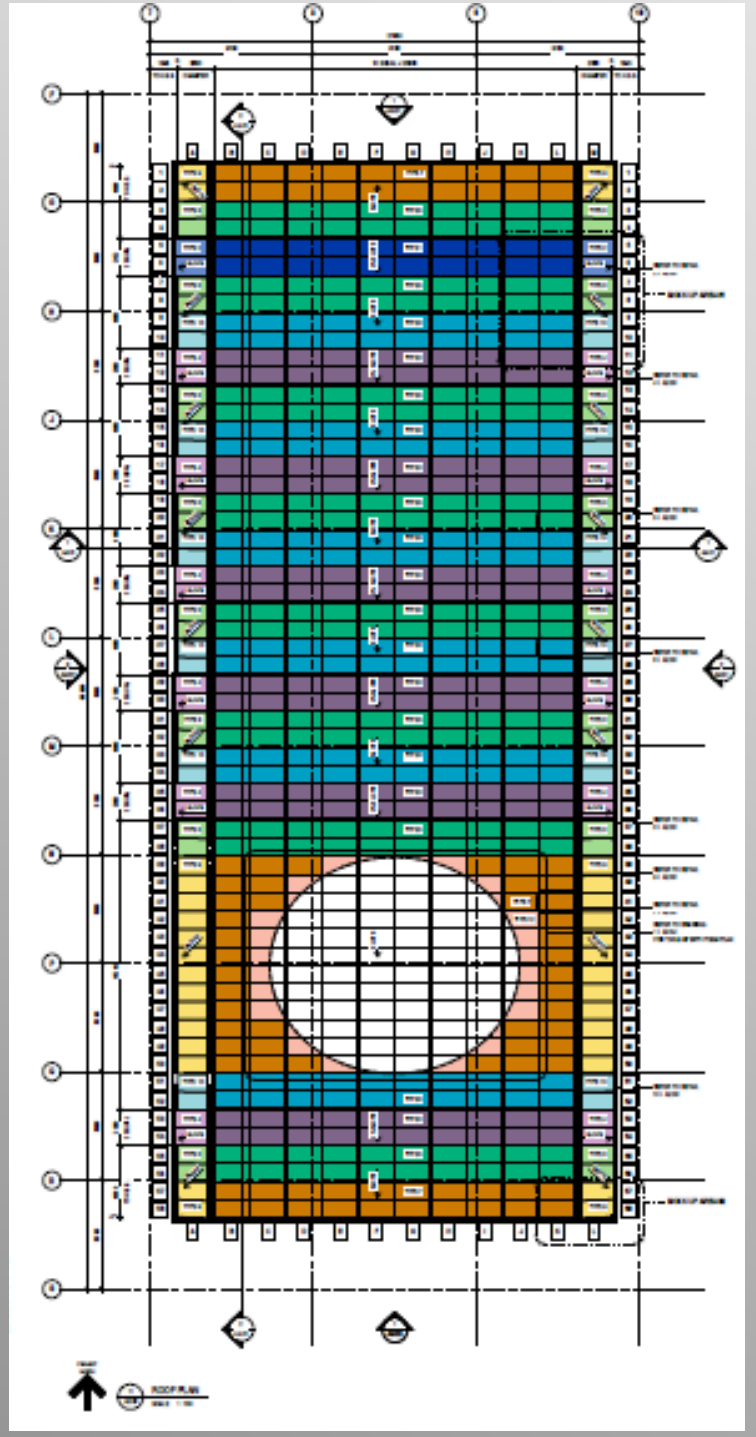
WIRING ROUTE – STRING INTERCONNECTION



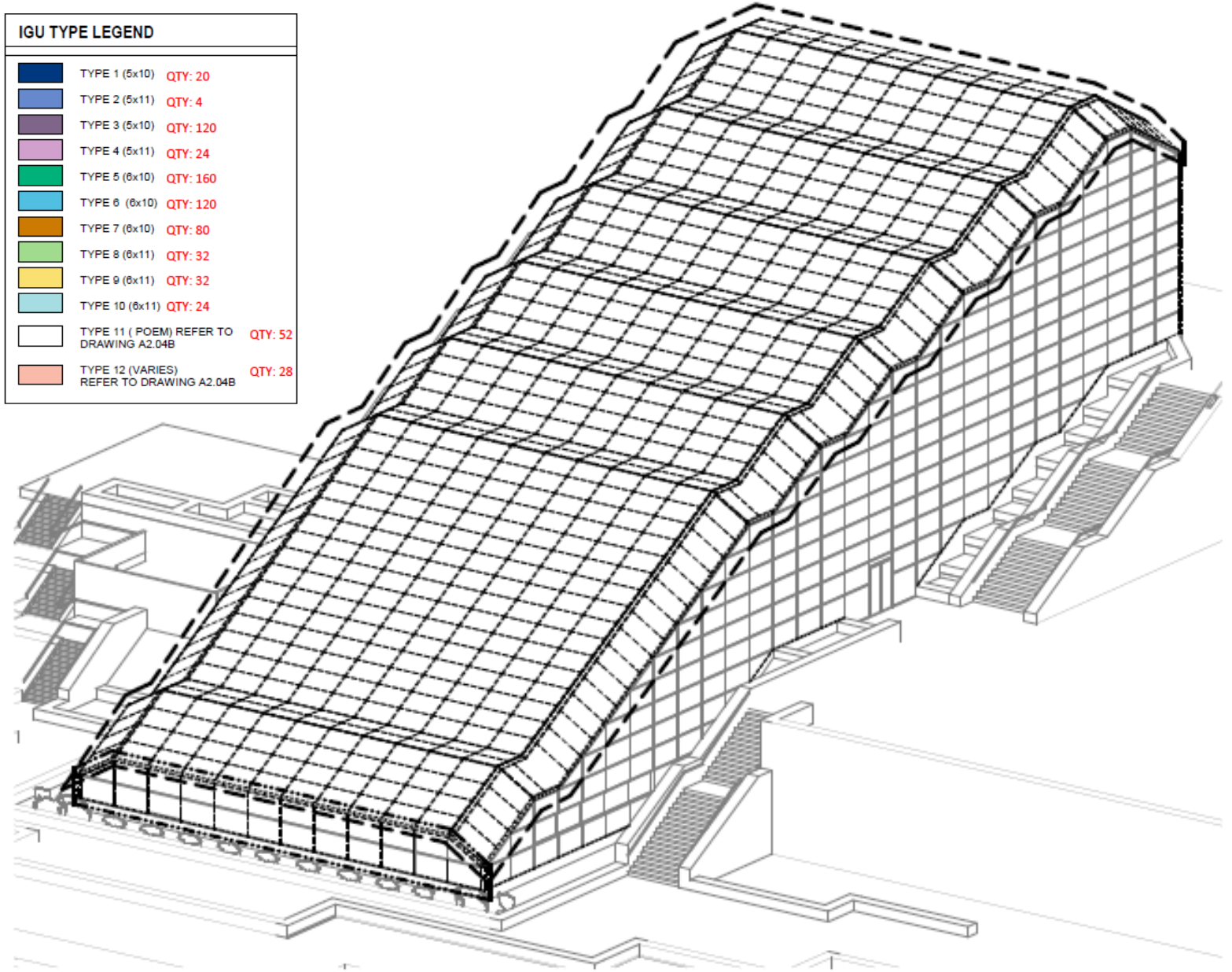


126 DIFFERENT TYPES OF UNITS FROM A TOTAL OF 700 UNITS



IGU TYPE LEGEND

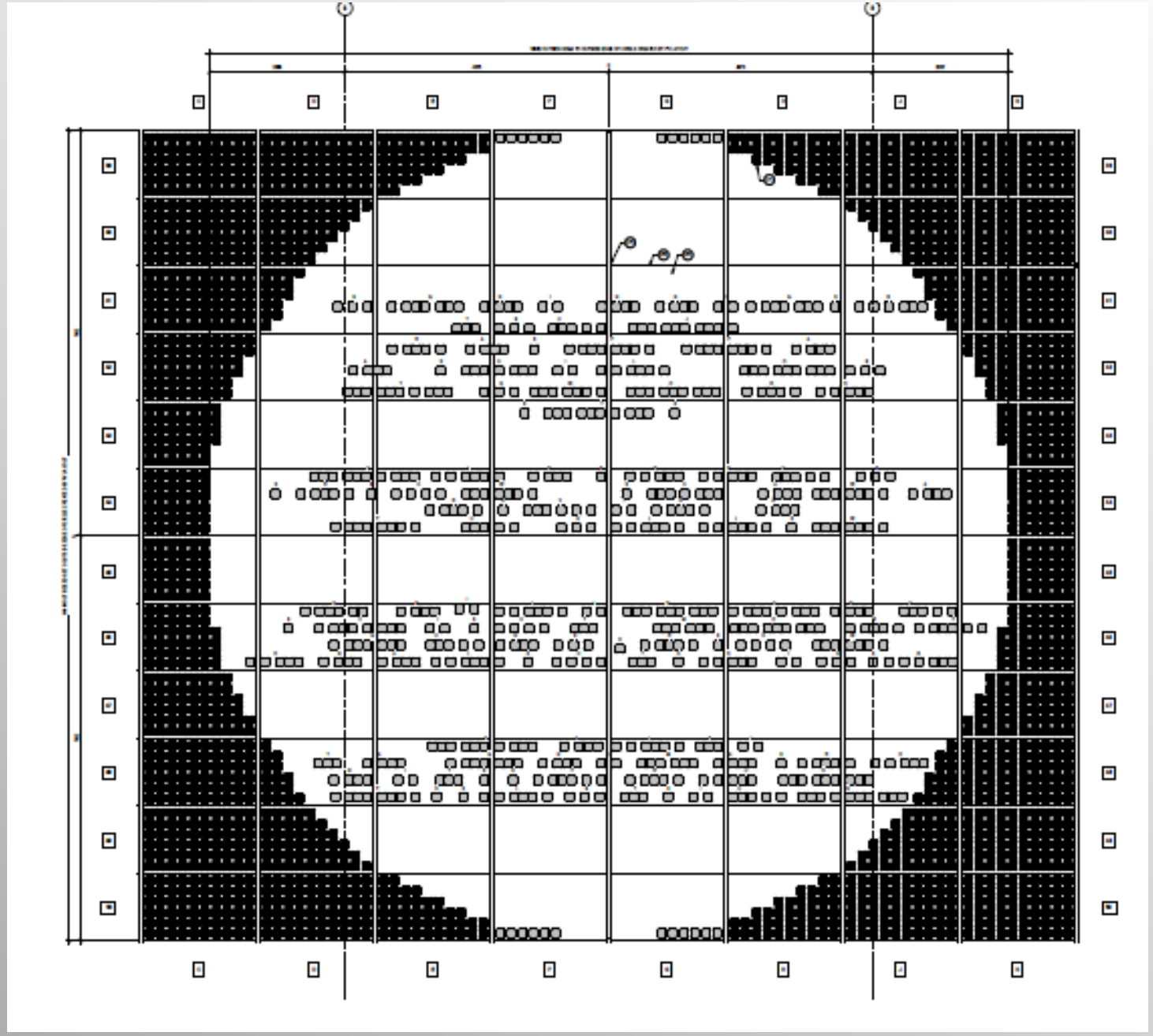
TYPE 1 (5x10)	QTY: 20
TYPE 2 (5x11)	QTY: 4
TYPE 3 (5x10)	QTY: 120
TYPE 4 (5x11)	QTY: 24
TYPE 5 (6x10)	QTY: 160
TYPE 6 (6x10)	QTY: 120
TYPE 7 (6x10)	QTY: 80
TYPE 8 (6x11)	QTY: 32
TYPE 9 (6x11)	QTY: 32
TYPE 10 (6x11)	QTY: 24
TYPE 11 (POEM) REFER TO DRAWING A2.04B	QTY: 52
TYPE 12 (VARIES) REFER TO DRAWING A2.04B	QTY: 28



ROOF DEMOLITION ISOMETRIC VIEW

CENTRAL OCULUS

The pattern of the cells opens up to a circular oculus with lines of Morse code that spell out a poem. It is an excerpt of Gifts of a River by E.D. Blodgett, a former Edmonton Poet Laureate



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THANK YOU!

Information Note: Architectural details, drawings and electrical schemes shown on this presentations thanks to Flyn Canada, Ltd. and Howell Mayhew Engineering, Inc