Feasibility Structural Analysis of Building for a Proposed Rooftop Solar PV System

For The Project:

Link Industrial Properties

429-449 Schiller St., Elizabeth, NJ 07206

Presented to:

Summit Ridge ENERGY

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Presented by:

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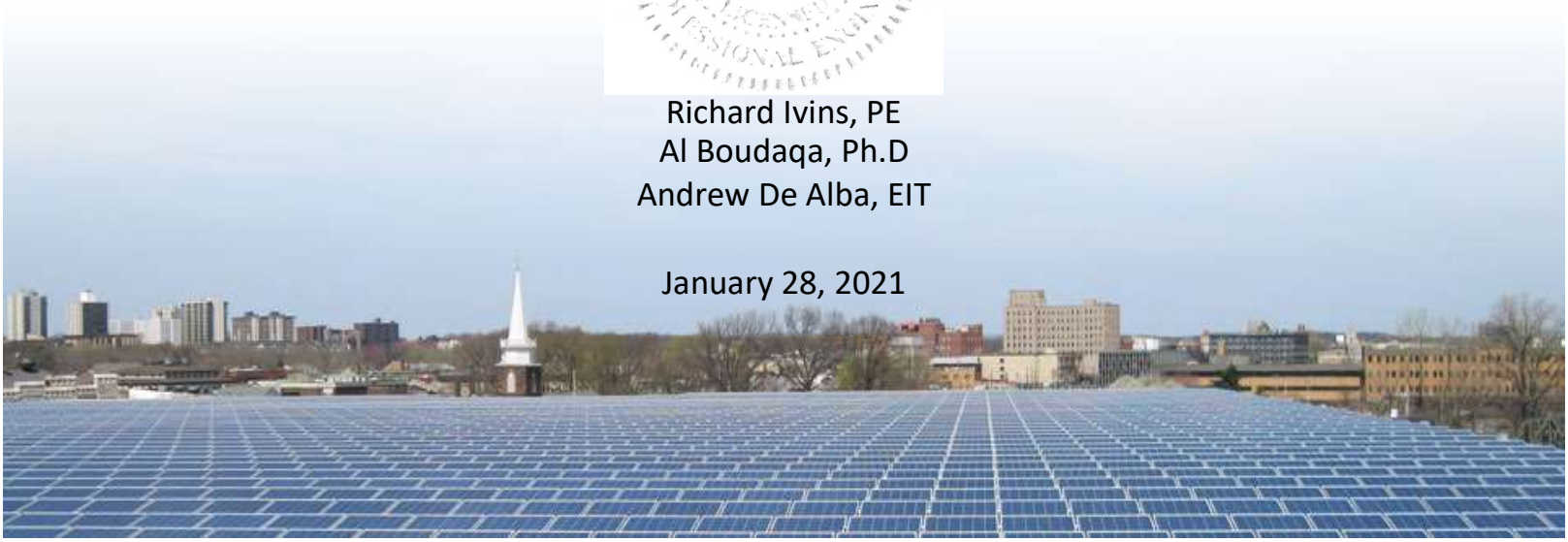

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Executive Summary

A (PV) Solar Array is proposed to be installed with modules mounted to a ballasted (and/or mechanically attached) racking system and supported on the rooftop of the subject building. Pure Power has performed a structural analysis and determined the following:

- Existing building is feasible for PV solar system.
- Reserved capacity & maximum allowable deck loads for existing roof Area A, where PV will be installed:

Reserved Capacity =	**6.0 psf**	
Deck Downward =	**450.0 lb**	(in a strip of 2'-0" wide X 5'-0" long)
Deck Uplift =	**400.0 lb**	(in a strip of 2'-0" wide X 5'-0" long)
Deck Shear =	**300.0 lb**	(in a strip of 2'-0" wide X 5'-0" long)
Maximum system weight =	**29,250 lb**	

- Reserved capacity & maximum allowable deck loads for existing roof Area B, where PV will be installed:

Reserved Capacity =	**6.0 psf**	
Deck Downward =	**275.0 lb**	(in a strip of 2'-0" wide X 16" long)
Deck Uplift =	**250.0 lb**	(in a strip of 2'-0" wide X 16" long)
Deck Shear =	**200.0 lb**	(in a strip of 2'-0" wide X 16" long)
Maximum system weight =	**18,750 lb**	

- Reserved capacity & maximum allowable deck loads for existing roof Area C, where PV will be installed:

Reserved Capacity =	**4.0 psf**	
Deck Downward =	**275.0 lb**	(in a strip of 2'-0" wide X 16" long)
Deck Uplift =	**250.0 lb**	(in a strip of 2'-0" wide X 16" long)
Deck Shear =	**200.0 lb**	(in a strip of 2'-0" wide X 16" long)
Maximum system weight =	**18,240 lb**	

Notes:

- Racking manufacturer shall select the racking system such that satisfies both the above specified uniform load reserve capacities and the maximum allowable downward, uplift and shear loads on the roof deck, respectively.

- The allowable deck loads will be dependent on the racking system used. At the time of the writing of this report, this information was not available. The allowable deck loads are subject to change upon receiving this information.

Structure (A)

The original structure is Link Industrial Properties building located at 429-449 Schiller St., Elizabeth, NJ 07206. The referenced building is a one story steel frame structure, which was built circa 1990s. The approximate total area is 7500 square feet. Typical roof construction consists of 1.5" Metal Deck x Gauge 22 supported by open web joists @ a max. of 5'-0" o.c.The joists are supported by a simply supported steel beam.

Structure (B)

The original structure is Link Industrial Properties building located at 429-449 Schiller St., Elizabeth, NJ 07206. The referenced building is a one story steel frame structure, which was built circa 1950s. The approximate total area is 6250 square feet. Typical roof construction consists of 19/32 Plywood Deck supported by wood joists. The joists are 2x10 spaced @ 16" o.c. and are supported by a simply supported steel beam.

Structure (C)

The original structure is Link Industrial Properties building located at 429-449 Schiller St., Elizabeth, NJ 07206. The referenced building is a one story steel frame structure, which was built circa 1950s. The approximate total area is 7500 square feet. Typical roof construction consists of 5" x 3/4" thick tongue and groove wood plank supported by wood joists. The joists are 2x12 spaced @ 16" o.c. and are supported by a steel truss.

Reserved Load Plan

(Area A Shaded Blue)
Reserved Capacity = 6 psf

(Area B Shaded Green)
Reserved Capacity = 6 psf

(Area C Shaded Purple)
Reserved Capacity = 4 psf

(Yellow Shaded Area - Reserved capacity undetermined)

(Red Shaded Area - No Solar)

Snow Drift Plan

Standard Conditions for Engineering Services on Existing Structures

- The analysis is based on the information gathered from the field and/or information provided to Pure Power Engineering and is assumed to be current and accurate.

- Unless noted otherwise, the structure and the foundation system are assumed to be in good condition, free of defects, and can achieve theoretical strength.

- It is assumed that the structure has been properly maintained and shall be properly maintained during its service. The superstructure and the foundation system are assumed to be designed with proper engineering practice and fabricated, constructed and erected in accordance with the design documents. Pure Power will accept no liability which may arise due to any existing deficiency in design, material, fabrication, erection, construction, etc. or lack of maintenance.

- The analysis results are only applicable for the proposed additions and alterations specified in this report. Any deviation of the proposed equipment and placement, etc., will require Pure Power to generate an additional structural analysis.

- The analysis does not include the design of the racking system or the ballast it requires. The analysis is performed to verify the capacity of the main structural system. Connections are assumed to have the capacity of the main structural members.

- Pure Power assumes that the existing building has NOT been modified or altered from its original design. Building landlord/client shall inform PPE with any kind of modification and/or alteration that may have been done to the existing building during its lifetime.

Proposed PV-Panels and Preliminary Design

- PV solar panels shall be installed on the roof as arrays on a ballasted racking system. A typical ballasted racking system is designed to resist wind uplift and sliding by placing concrete blocks (ballast) as counterweight on the racks. The system does not increase uplift on the building because the ballast should be designed to resist the additional uplift in order to provide the code required factor of safety.

- If the PV racking system is mechanically attached to the roof deck, then the uplift and shear forces at each mechanical attachment are not to exceed the capacity noted in this report under the conclusion section.

- It is assumed that the panels will be approximately 12 inches above the rooftop at the high end.

- It is assumed that the average design weight includes the weight of the panels, racking system and the ballast and all required assemblies.

Existing Building Code Allowance

- Pursuant to International Existing Building Code section 806.2, any existing gravity load-carrying structural element for which additions and/or alterations cause an increase in design gravity load of no more than 5 percent, shall be permitted to remain unaltered, thus considered to be code-compliant and adequate. Any existing gravity load- carrying structural element for which additions and/or alterations cause an increase in design gravity loads exceeding 5 percent is checked against the applicable Code criteria for new structures.

- Pursuant to International Existing Building Code Sections 806.3, any existing lateral load-carrying structural element whose demand-capacity ratio with the addition and/or alteration considered is no more than 10 percent greater than its demand-capacity ratio with the addition and/or alteration ignored shall be permitted to remain unaltered, thus considered to be Code-compliant and adequate. If the demand- capacity ratio increase is more than 10 percent, the subject structural element is checked against the applicable Code criteria for new structures.

- Pursuant International Building Code section 1607.13.5.1, where PV panels are installed on building roof, it is not necessary to include roof live load in the area(s) covered by the panels when these area(s) are inaccessible, or signs are posted prohibiting storage under the panels. Therefore, Pure Power has applied the roof live/snow load in all areas that are still accessible and subject to foot traffic, maintenance workers, storage, etc., but not directly under the modules.

Codes and References

2018 International Building Code, NJ Edition

Minimum Design Loads for Buildings and Other Structures, ASCE 7-16

Standard Specifications for Steel Joists & Joist Girders, SJI 44th Edition

Specifications for Structural Steel Buildings, ANSI/AISC 360-16

Design Criteria

Snow Load (Service)

Ground Snow Load:	20 psf
Risk Category:	II
Snow Exposure: C_e:	1.0
Snow Load Important Factor I_s:	1.0
Thermal Factor C_t:	1.0
Flat Snow Load:	**20.0 psf**

Roof Live Load (Service) 20.0 psf

Note: The racking manufacturer/the racking manufacturer's structural engineer shall be responsible to verify the design criteria when designing the racking system.

Analysis Assumptions for Roof Area A

The design snow load was obtained from 2018 IBC. Based on the site visit conducted on 01/15/2021, the design live and dead loads in this report were assumed as listed below:

Total Roof DL =	**20.0 psf**	*
Live Load	20.0 psf	
Snow Load	30.0 psf	
Total Roof Load =	**50.0 psf**	

PPE understands that the area where the clear space between the panels and rooftop is not more than 24 in. Therefore, as per the current state code (section 1607.13.5.1), roof live load does NOT need to be considered on areas where the proposed PV system will be installed.

The proposed PV system is to weigh a maximum **6.0 psf**

Therefore, the proposed loading, including the weight of the PV system is as follows:

Roofing & Insulation	4.0 psf	
Metal Deck	2.0 psf	
Joists	2.0 psf	
Girders	5.0 psf	
MEP, Sprinklers, & Misc.	7.0 psf	
Total Roof DL =	**20.0 psf**	*
PV System Weight	6.0 psf	
Roof SL =	20.0 psf	
Total Roof Load =	**46.0 psf**	

*Add 2 psf dead load for suspended ceiling @ office area

The design roof live load is greater than the design roof snow load, and therefore, governs the design. Photovoltaic (PV) modules are not designed to support any overhead foot traffic, and their low profile nature prevents access and foot traffic below. For this reason, the dead load of the PV system and roof live loads are assumed to act non-concurrently. Since the weight of the proposed solar array is less than the design roof live load minus the design roof snow load, it can be concluded that the array does not increase the gravity loads carried by the roof framing. Therefore, per IBC 1607.13.5.1 and IEBC Section 806.2, the structure may remain unaltered.

Analysis Assumptions for Roof Area B

The design snow load was obtained from 2018 IBC. Based on the site visit conducted on 01/15/2021, the design live and dead loads in this report were assumed as listed below:

Total Roof DL =	**18.5 psf**
Live Load	20.0 psf
Snow Load	30.0 psf
Total Roof Load =	**48.5 psf**

PPE understands that the area where the clear space between the panels and rooftop is not more than 24 in. Therefore, as per the current state code (section 1607.13.5.1), roof live load does NOT need to be considered on areas where the proposed PV system will be installed.

The proposed PV system is to weigh a maximum **6.0 psf**

Therefore, the proposed loading, including the weight of the PV system is as follows:

Roofing & Insulation	4.0 psf	
9/16" Wood Sheathing	2.0 psf	
Wood Joists	5.0 psf	
Girders	2.5 psf	
MEP, Sprinklers, & Misc.	5.0 psf	
Total Roof DL =	**18.5 psf**	
PV System Weight	6.0 psf	
Roof SL =	20.0 psf	*
Total Roof Load =	**44.5 psf**	

*All snow drift load cases were considered in the design

The design roof live load is greater than the design roof snow load, and therefore, governs the design. Photovoltaic (PV) modules are not designed to support any overhead foot traffic, and their low profile nature prevents access and foot traffic below. For this reason, the dead load of the PV system and roof live loads are assumed to act non-concurrently. Since the weight of the proposed solar array is less than the design roof live load minus the design roof snow load, it can be concluded that the array does not increase the gravity loads carried by the roof framing. Therefore, per IBC 1607.13.5.1 and IEBC Section 806.2, the structure may remain unaltered.

Analysis Assumptions for Roof Area C

The design snow load was obtained from 2018 IBC. Based on the site visit conducted on 01/15/2021, the design live and dead loads in this report were assumed as listed below:

Total Roof DL =	**19.0 psf**
Live Load	20.0 psf
Snow Load	20.0 psf
Total Roof Load =	**39.0 psf**

PPE understands that the area where the clear space between the panels and rooftop is not more than 24 in. Therefore, as per the current state code (section 1607.13.5.1), roof live load does NOT need to be considered on areas where the proposed PV system will be installed.

The proposed PV system is to weigh a maximum **6.0 psf**

Therefore, the proposed loading, including the weight of the PV system is as follows:

Roofing & Insulation	4.0 psf	
3/4" Tongue and Groove Deck	2.5 psf	
Wood Joists	5.0 psf	
Steel Truss	2.5 psf	
MEP, Sprinklers, & Misc.	5.0 psf	
Total Roof DL =	**19.0 psf**	
PV System Weight	4.0 psf	
Roof SL =	14.0 psf	*
Total Roof Load =	**37.0 psf**	

*All snow drift load cases were considered in the design

The design roof live load is greater than the design roof snow load, and therefore, governs the design. Photovoltaic (PV) modules are not designed to support any overhead foot traffic, and their low profile nature prevents access and foot traffic below. For this reason, the dead load of the PV system and roof live loads are assumed to act non-concurrently. Since the weight of the proposed solar array is less than the design roof live load minus the design roof snow load, it can be concluded that the array does not increase the gravity loads carried by the roof framing. Therefore, per IBC 1607.13.5.1 and IEBC Section 806.2, the structure may remain unaltered.

Conclusion

Based on our experience and engineering analysis of the information available at the time of this writing, it is the opinion of this organization that the added stresses due to the weight of the proposed PV modules are considered acceptable and will not exceed the capacity of the existing roof structure. The proposed PV modules may be installed at Link Industrial Properties under the conditions outlined in the body of this report.

Do not stage pallets on roof unless staging plan drawing is provided by PPE.

This report does not represent an approval of the proposed PV system design. It is the racking designer's responsibility to ensure any proposed racking system is within the limits stated in this report and their system is designed in accordance with the requirements in the governing building code. PPE can review the existing framing adequacy for anchorage reaction loads upon request and if the racking design are supplied to PPE by the racking designer.

Sincerely,

Richard Ivins, PE
Al Boudaqa, Ph.D
Andrew De Alba, EIT