Township Archives
Township of Brick, NJ
401 Chambers Bridge Rd, Brick, NJ 08723

This File Contains Personal Identifiable Information of Private Citizen(s).

Certain information contained in this file is ***Exempt from Release*** under the Open Public Records Act (OPRA) (Public Law 2001, CHAPTER 404 (N.J.S.A. 47:1A-1 et seq.)) and Executive Orders issued by the Governor of New Jersey. The following information ***MUST*** be redacted prior to release:

- Social Security Numbers
- Drivers' License Numbers
- Unlisted Phone Numbers
- Credit Card Numbers
- Bank Account Numbers and Balances

For further information, consult with the Township Clerk, Township Archivist or Township Attorney prior to release.

Bryan J. Dickerson, CA, CMR
Township Archivist

Issued: 8 January 2020

BLOCK 671 LOT 1.01 QUALIFICATION CODE _____ ADDRESS (SITE) 1 Brick Plaza PERMIT NO. 19-1895

CONSTRUCTION PERMIT APPLICATION

19-002237

Applicant Completes: Sections I, II, III (optional), IV, VI, and VII

I. IDENTIFICATION

1. Proposed Work Site at: 1 Brick Plaza, Brick Township, NJ 08723
2. Name of Owner in Fee: FEDERAL REALTY INVESTMENT TRUST
   Tel. (415) 722-3704 e-mail bklapper@safarienergy.com
   Address PO BOX 92129 (street) SOUTHLAKE, TX (municipality) 76092 (zip code)
3. Ownership in Fee: Public _____ Private X
4. Principal Contractor: MJM Electric Inc Tel. (732) 859-0314
   Address 7 South Tamarack Dr e-mail mike@mjmelectricnj.com
   Brielle, NJ 08730
   License No. OR, if new home, Builder Reg. No. 12715B Exp. Date 03/30/2021
   Home Improvement Contractor Registration No. or Exemption Reason _____
   Federal Emp. ID No. 22-348574 FAX: _____
5. Architect or Engineer French & Parrello Associates Contact Amin Gomaa
   Address 1800 Rte 34 Ste 101, Wall, NJ 07719 e-mail amin.gomaa@fpaenginee
   Tel. (732) 312-9646 FAX: (732) 312-9801
6. Responsible Person in Charge once Work has Begun Michael J McKiever
   Tel. (732) 859-0314 FAX: _____

V. FEE SUMMARY (for office use only)

		Update	Update
1. Building	$ 1072		
2. Electrical	750		
3. Plumbing			
4. Fire Protection			
5. Elevator Devices			
6. Subtotal			
7. Less 20% for State Plan Review	$		
8. Subtotal	$ 183-DCA		
9. State Permit Surcharge Fee	2 15		
10. Subtotal			
11. Cert. of Occupancy			
12. Other			
13. TOTAL	$ 2080		

VI. BUILDING/SITE CHARACTERISTICS

		(office use only)
1. Number of Stories	2	
2. Height of Structure	24 ft.	
3. Area — Largest Floor	58,250 sq. ft.	
4. New Building Area	sq. ft.	
5. Volume of New Structure		
6. Max. Live Load		
7. Max. Occupancy Load		
8. If Industrialized Building: State Approved ____ HUD ____		
9. Total Land Area Disturbed	sq. ft.	
10. Flood Hazard Zone		
11. Base Flood Elevation	ft.	
12. Wetlands yes ____ no X		

COMMERCIAL

Solar Panels

Rolled Plans

IIa. PROPOSED WORK

☐ Minor Work ☐ New Building ☐ Addition ☐ Demolition
☐ Repair ☒ Alteration ☐ Renovation ☐ Reconstruction
☐ Asbestos Abat. - Subch. 8 ☐ Lead Hazard Abatement ☐ Radon Remediation ☐ Annual Permit

IIb. SUBCODES

(Check all that apply)

FOR OFFICE USE ONLY (Optional)

	Est. Cost	Plans Rec'd by	Date Rec'd	Rejection Date	Approval Date	Re-viewer	Resubmission Dates Approval	Resubmission Dates Rejection	Re-viewer
☒ Building	21,441				07/03/19	MEK			
☒ Electrical	74,880	6/14/19			7/2/19	PS			
☐ Plumbing									
☐ Fire Protection									
☐ Elevator		Eng.	Exempt		6/26/19	Eee			
TOTAL COST	$96,321								

VII. DESCRIPTION OF BUILDING USE

A. RESIDENTIAL *(primary use)*
1. State Specific Use: _____
2. Use Group, Proposed: Select Group
3. Change in Use Group, Indicate Present: Select Group
4. No. of dwelling units: *Total Units* *Income-restricted*
   Gained, Sale ____ ____
   Gained, Rental ____ ____
   Lost, Sale ____ ____
   Lost, Rental ____ ____

B. NON-RESIDENTIAL *(primary use)*
1. State Specific Use: _____
2. Use Group, Proposed: M
3. Change in Use Group, Indicate Presen M

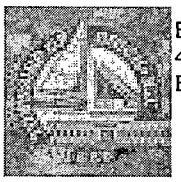
C. MIXED USE -List secondary use(s): _____
D. Construct. Classification: Present _____
Proposed _____

III. PLAN REVIEW (optional)

DO YOU WANT:
1. ☐ Partial Releases
2. ☐ Prototype Processing

IV. DOES OR WILL YOUR BUILDING CONTAIN ANY OF THE FOLLOWING?

1. ☐ Elevators/Escalators/Lifts/ Dumbwaiters/Moving Walks
2. ☐ High Pressure Boilers
3. ☐ Pressure Vessels
4. ☐ Refrigeration Systems
5. ☐ Cross-Connections/Backflow Preventers
6. ☐ Hazardous Uses/Places of Assembly
7. ☐ Sprinklers/Standpipes
8. ☐ Smoke Control Systems in Open Wells
9. ☐ Underground Storage Tanks
10. ☐ Swimming Pools, Spas and Hot Tubs
11. ☐ LPGas Tanks
12. ☐ Fire Alarm



Brick Township
401 Chambersbridge Rd
Brick, NJ 08723

Certificate

Construction Code Division
(Certificate of Approval)

Date Issued 8/12/2020
Control Number C-19-002237
Permit Number 19-1895
Permit Issue Date 7/22/2019
Certificate Number 19-1895

Identification

Work Site Location: 56 CHAMBERS BRIDGE RD. Brick Township, NJ Block: 671 Lot: 1.01 Qual:

Owner in Fee: FEDERAL REALTY INVESTMENT TRUST %

Owner Address: PO BOX 92129 (ALTUS GROUP SOUTHLAKE TX 76092

Telephone: (415) 722-3704

Contractor MJM ELECTRIC INC

Address 7 SOUTH TAMARK DRIVE BRIELLE NJ 08730

Telephone: (732) 859-0314 Fax: Federal Emp. Number: 22-3485744

License Number or Builders Registration Number:

Home Warranty Number: Type of Warranty Plan: ☐ State ☐ Private

Use Group: A-2 Construction Classification:

Maximum Live Load: 0 Maximum Occupancy Load: 0

Description of Work/Use: SOLAR PANELS - - LA FITNESS ...REINSTALL SOLAR

Certificate Comments:

☐ **Certificate of Occupancy**
This serves notice that said building or structure has been constructed in accordance with the New Jersey Uniform Construction Code and is approved for occupancy.

☑ **Certificate of Approval**
This serves notice that the work completed has been constructed or installed in accordance with the New Jersey Uniform Construction Code and is approved. If the permit was issued for minor work, this certificate was based upon what was visible at the time of inspection.

☐ **Certificate of Continued Occupancy**
This serves notice that based on a general inspection of the visible parts of the building there are no imminent hazards and the building is approved for continued occupancy.

☐ **Temporary Certificate of Compliance**
The following conditions must be met no later than
or the owner will be subject to fine or order to vacate:
This certificate has an expiration date of:
Conditions to be met:

☐ **Certificate of Clearance - Lead Abatement 5:17**
This serves notice that based on written certification, lead abatement was performed as per NJAC5:17 to the following extent.

☐ Total removal of lead-based paint hazards in scope of work
☐ Partial or limited time period (years); see file

☐ **Certificate of Clearance - Asbestos Abatement**
This serves notice that based on written certification, asbestos abatement was performed to the following extent.

☐ Total removal of asbestos hazards in scope of work
☐ Partial or limited time period (years); see file

☐ **Certificate of Compliance**
This serves notice that said potentially hazardous equipment has been installed and/or maintained in accordance with the New Jersey Uniform Construction Code and is approved for use until

☐ **Temporary Certificate of Occupancy**
The following conditions must be met no later than:
or the owner will be subject to fine or order to vacate:
This certificate has an expiration date of:
Conditions to be met:

David J. Newman Jr.

Construction Official
Date Printed: 8/12/2020

U.C.C. F260 (rev. 08/05)

Fee: $0.00
Check Number:
Collected By:

ELECTRICAL SUBCODE
TECHNICAL SECTION

NEW JERSEY UNIFORM CONSTRUCTION CODE

Date Received 7/22/19
Control #
Date Issued
Permit # 19-1895

A. IDENTIFICATION—APPLICANT: COMPLETE ALL APPLICABLE INFORMATION. WHEN CHANGING CONTRACTORS, NOTIFY THIS OFFICE. CALL UTILITY DIG NO: 1-800-272-1000.

Block 671 Lot 1.01 Qualification Code

Work Site Location 1 Brick Plaza, Brick Township, NJ 08723 LA Fitness Solar

Owner in Fee: FEDERAL REALTY INVESTMENT TRUST

Tel. (415) 722-3704 e-mail bklapper@safarienergy.com

Address PO BOX 92129 (street) SOUTHLAKE, TX (municipality) 76092 (zip code)

Contractor: MJM Electric Inc Tel. (732) 859-0314

Address 7 South Tamarack Dr e-mail mike@mjmelectricnj.com
Brielle, NJ 08730

Contractor License No. 12715B Exp. Date 03/31/2021

Home Improvement Contractor Registration No. or Exemption Reason

Federal Emp. ID No. 22-348574 FAX:

B. ELECTRICAL CHARACTERISTICS

Use Group Present M Proposed M

[ ] Pole/Pad # [ ] Temporary [ ] Other

Building Occupied as Utility Co.

Est. Cost of Elec. Work $ 74,880

C. CERTIFICATION IN LIEU OF OATH

I hereby certify that I am the (agent of) owner of record and am authorized to make this application and perform the work listed on this application.

Applicant sign/Contractor sign and seal here: Michael J McKiever

Print name here: Michael J McKiever

[X] Licensed Elec. Contractor [ ] Certif'd Landscape Irrigation Cont'r [ ] Exempt Applicant

D. TECHNICAL SITE DATA

DESCRIPTION OF WORK:
Reinstall existing rooftop PV solar system

QTY.	SIZE	ITEMS	FEE (Office Use Only)
		Lighting Fixtures	
		Receptacles	
		Switches	
		Detectors	
		Light Poles	
		Motors—Fract. HP	
		Emergency & Exit Lights	
		Communications Points	
		Alarm Devices/F.A.C. Panel	
624		240W PV modules	
624		TOTAL NUMBERS	$
		Pool Permit/with UW Lights	
		Storable Pool/Spa/Hot Tub	
		KW Elec. Range/Receptacle	
		KW Oven/Surface Unit	
		KW Elec. Water Heater	
		KW Elec. Dryer/Receptacle	
		KW Dishwasher	
		HP Garbage Disposal	
		KW Central A/C Unit	
		HP/KW Space Heater/Air Handler	
		KW Baseboard Heat	
		HP Motors 1/+ HP	
		KW Transformer/Generator	
		AMP Service	
		AMP Subpanels	
		AMP Motor Control Center	
		KW Elec. Sign/Outline Light	
1		14.7 KW PV System	

COMMERCIAL

Administrative Surcharge	$
Minimum Fee	$
State Permit Surcharge Fee	$
TOTAL FEE	$

JOB SUMMARY (Office Use Only)

PLAN REVIEW
[ ] No Plans Required
[ ] Partial -Underslab Utilities Approved
Date: Approved by:
[✓] Electric Plans Approved
Date: 7/24/19 Approved by: PJC
Joint Plan Review Required:
[ ] Bldg. [ ] Plumb. [ ] Fire. [ ] Elev.
SUBCODE APPROVAL for PERMIT
Date: 7/24/19
Approved by: PJC
SUBCODE APPROVAL for CERTIFICATE
[ ] CO [ ] CCO [X] CA
Date: 7-15-2020
Approved by: WR

INSPECTIONS Type:	Dates (Month/Day) Failure	Failure	Approval	Initial
Rough				
Barrier-Free				
Trench				
Temp. Serv.				
Constr. Serv.				
TCO				
Other				
Service				
Final			7-15-2020	WR
Barrier-Free				

Temp. Cut-in-Card Date Issued
Final Cut-in-Card Date Issued
Annual Pool Inspection
Date of Grounding and Bonding Certification

U.C.C. F120 (rev. 11/09)
Internet version

Applicant: When submitting this form to your Local Construction Code Enforcement Office, please provide one original plus three photocopies.

BUILDING SUBCODE
TECHNICAL SECTION

Date Received 7/22/19
Control #

Date Issued
Permit # 19-1895

A. IDENTIFICATION—APPLICANT: COMPLETE ALL APPLICABLE INFORMATION. WHEN CHANGING CONTRACTORS, NOTIFY THIS OFFICE. CALL UTILITY DIG NO: 1-800-272-1000.

Block 671 Lot 1.01 Qualification Code

Work Site Location 1 Brick Plaza, Brick Township, NJ 08723 L.A. FITNESS

Owner in Fee: FEDERAL REALTY INVESTMENT TRUST

Tel. (415) 722-3704 e-mail bklapper@safarienergy.com

Address PO BOX 92129 (street) SOUTHLAKE, TX (municipality) 76092 (zip code)

Contractor: MJM Electric Inc Tel. (732) 859-0314

Address 7 South Tamarack Dr e-mail mike@mjmelectricnj.com

Brielle, NJ 08730

Contractor License No. or Builder Registration No. 12715B Exp. Date 03/31/2021

Home Improvement Contractor Registration No. or Exemption Reason

Federal Emp. ID No. 22-348574 FAX:

JOB SUMMARY (Office Use Only)

PLAN REVIEW	Date	Initial
[ ] No Plans Required		
[✓] All	07/03/19	MEK
[ ] Footings/Foundations		
[ ] Structural/Framework		
[ ] Exterior		
[ ] Interior		

Joint Plan Review Required:
[ ] Elec. [ ] Plumb. [ ] Fire [ ] Elevator

SUBCODE APPROVAL for PERMIT
Date: 07/03/19
Approved by: MEK

SUBCODE APPROVAL for CERTIFICATE
[ ] CO [ ] CCO [✓] CA
Date: 07/15/20
Approved by: MEK

INSPECTIONS Type:	Dates (Month/Day) Failure	Failure	Approval	Initial
Footing				
Footing Bonding				
Foundation				
Slab				
Frame				
Truss Sys./Bracing				
Barrier-Free				
Insulation				
Finishes -Base Layer				
Finishes -Final				
Energy				
Mechanical				
TCO				
Other				
Final			07/15/20	MEK
Barrier-Free				

B. BUILDING CHARACTERISTICS

Use Group Present M Proposed M

No. of Stories 2

Height of Structure 24 ft.

Area — Largest Floor 58,250 sq. ft.

New Bldg. Area/All Floors sq. ft.

Volume of New Structure cu. ft.

Max. Live Load

Max. Occupancy Load

Constr. Class Present Proposed

If Industrialized Building:
State Approved HUD

Est. Cost of Bldg. Work:

1. New Bldg. $ 21,441
2. Rehabilitation $
3. Total (1+ 2) $ 21,441

C. CERTIFICATION IN LIEU OF OATH

I hereby certify that I am the (agent of) owner of record and am authorized to make this application.

Sign here:

Print name here: Michael J McKiever

D. TECHNICAL SITE DATA

DESCRIPTION OF WORK

Reinstall existing rooftop PV solar system after reroof, utilizing (624) 240W modules, existing inverters, and a Panelclaw ballasted racking system

COMMERCIAL

TYPE OF WORK:
- [ ] New Building
- [ ] Addition
- [ ] Rehabilitation
- [ ] Roofing
- [ ] Siding
- [ ] Fence _____ Height (exceeds 6')
- [ ] Sign _____ Sq. Ft.
- [ ] Pool
- [ ] Retaining Wall _____ Sq. Ft.
- [ ] Asbestos Abatement Subchapter 8
- [ ] Lead Haz. Abatement NJAC 5:17
- [ ] Radon Remediation
- [X] Other Alteration
- [ ] Demolition

FEE (Office Use Only)

$

Administrative Surcharge $

Minimum Fee $

State Permit Surcharge Fee $

TOTAL FEE $

Applicant: When submitting this form to your Local Construction Code Enforcement Office, please provide one original plus three photocopies.

RECEIVING CLERK CD
DATE REC'D 6/5/19

ZONING PERMIT APPLICATION

PERMIT # ZP-9-00805
DATE ISSUED 7/22/19

BLOCK: 671 LOT: 1.01 QUALIFIER: _____ SITE ADDRESS: 1 Brick Plaza

IDENTIFICATION:

1. NAME OF OWNER IN FEE: Federal Realty Investment Trust
   COMPLETE ADDRESS: PO Box 92129 South Lake TX 76092
   PHONE # 415 782 3704 EMAIL: BKlapper@sfenergy.com
2. NAME OF APPLICANT: MJM Electric Inc
   APPLICANT ADDRESS: 7 South Tamarack Dr
   Brielle NJ 08730
   PHONE # 732 859-0314 EMAIL: mke@mjmelectricnj.com
3. RESPONSIBLE PERSON FOR WORK: Michael J McKiever
   PHONE# 732 859-0314 FAX# _____
4. SIGNATURE OF APPLICANT: [signature]

FOR OFFICE USE ONLY

FEE SUMMARY:

APPLICATION FEE: $ 25
OTHER: $ _____
TOTAL: $ 25

REQUIRED BY APPLICANT

RESIDENTIAL: _____
COMMERCIAL: V
EXISTING USE: Institutional
PROPOSED USE: " "

BOARD APPROVAL: ___ PB ___ ZB
RESOLUTION#: _____
APPROVAL DATE: _____

PROJECT DESCRIPTION: (PLEASE CHECK APPLICABLE WORK & DESCRIBE)

*NEW BUILDING: _____ *ADDITION X *ALTERATION _____ *PORCH _____ *DECK _____

POOL: ABOVE GROUND _____ IN GROUND _____ FENCE: HEIGHT _____ TYPE _____ MATERIAL _____

HEIGHT: _____ (*IF APPLICABLE)

OTHER Re-install PV System panels

DESCRIPTION: _____

ZONING REVIEW:

DATE REVIEWED: 6-24-19 DATE DENIED: _____ DATE APPROVED: 6-24-19 INTLS: [signature]

(SEE BACK PAGE)

TOWNSHIP OF BRICK ZONING CHECKLIST

1) **Four (4) copies of plot plan containing:**

- All existing and proposed structures
- All dimensions of the lot and structures
- All setbacks from the structures to the property lines
- All adjacent streets and waterways
- If applicable, include a copy of the Zoning Board of Adjustment Resolution, the date that the map was signed, and/or the date that the subdivision map was filed with the Ocean County Clerk, along with the file map and number.

2) **Two copies of the plans with dimensions and heights noted:**

- Floor plans and elevations
- Signed site plans
- Property map
- Survey map

Choose which is applicable for submission

3) **Plot plans and building plans must match for complete review**

NOTE: NO PARTIAL, TAPED, FAXED, REDUCED OR ENLARGED COPIES CAN BE ACCEPTED

01/2010

Brick Township
401 Chambers Bridge Rd.
Brick, NJ 08723
(732) 262-1041

Date Issued: 7/22/19
Application Number: ZA-19-00758
Application Date: 6/20/2019
Project Number:
Permit Number: ZP19-00805
Fee: $75.00

Zoning Permit

Worksite Location: **56 CHAMBERS BRIDGE RD. Brick Township, NJ 08723**

Owner: **FEDERAL REALTY INVESTMENT TRUST %**
Address: **PO BOX 92129 (ALTUS GROUP SOUTHLAKE, TX 76092**

Applicant: **MJM ELECTRIC INC**
Address: **7 SOUTH TAMARK DRIVE BRIELLE, NJ 08730**

Block: **671** Lot: **1.01** Qualifier: Zone: **B-3**

This Certifies that an application for the issuance of a Zoning Permit has been examined.

Present Use: **Commercial**

☐ Non Conforming Use ☐ Non Conforming Structure

Proposed Use: **Commercial (Brick Plaza)**

Work Description:
Solar Energy System - 624- 240W Suntech Solar, 6.615kW Polar Bear III HD, mounted on the roof of the building. (Re-Install for Brick Plaza)

Additional Zoning Permit is required for additional work.

Application Approved Date: 6/24/2019

Upon review it was determined that the Zoning Permit:

☑ Permitted by Ordinance
☐ Permitted by Variance approved on:
☐ Approved with Conditions
☐ Valid Nonconforming Use/Structure is established by
☐ Zoning Board of Adjustment ☐ Zoning Officer

Christopher J. Romano, Zoning Officer — 6/24/2019 Date

CERTIFICATION IN LIEU OF OATH

I. OWNER SECTION (to be completed if the applicant is the owner in fee)

I hereby certify that I am the owner in fee of the property listed on Page 1.

Mark the following applicable boxes:

A. ( ) I further certify that a new home (private residence) will be constructed on this property for my own use and occupancy. This dwelling is to be occupied by myself and is not to be used for any purpose other than single family residential use. I attest that all construction, plumbing, or electrical work will be done, in whole or in part, by me or by subcontractors under my supervision, in accordance with all applicable laws; and, I further acknowledge that said new home is not covered under the New Home Warranty and Builders Registration Act (N.J.S.A. 46:3B-1 et seq.) and that such fact shall be disclosed to any person purchasing this property within ten years of the date of issuance of a certificate of occupancy.

I UNDERSTAND THAT IN MARKING BOX A, I ACKNOWLEDGE THAT I AM ASSUMING RESPONSIBILITY FOR THE WORK DONE ON SAID PROPERTY, THE CONDITION OF THE PROPERTY PRIOR TO, DURING, AND AFTER ANY WORK PERFORMED, AND FOR THE PERFORMANCE OF THE SUBCONTRACTORS I HIRE, EMPLOY, OR OTHERWISE CONTRACT OR WITH WHOM I MAKE AGREEMENTS TO PERFORM WORK. I AM VOLUNTARILY AND KNOWINGLY ASSUMING THIS RESPONSIBILITY.

B. ( ) I further certify the following as required by the New Jersey Uniform Construction Code, N.J.A.C. 5:23-2.15(f)1.ix:

I personally prepared the plans submitted for: 1) the new home referred to in A.; or, 2) an addition, alteration, renovation, or repair to an existing single family residence owned and occupied by myself and located on the property listed on Page 1; or, 3) a new structure that will be physically separate from, but that will be deemed part of, an existing single family residence that is owned and occupied by myself and located on the property listed on Page 1.

C. ( ) I further certify that I will perform or supervise the following work:
C.1. ( ) Building C.2. ( ) Fire Protection

I further certify that I will perform the following work:
C.3. ( ) Electrical C.4. ( ) Plumbing

D. ( ) I agree to advise all contractors on this project that they are required to be registered with the New Jersey Division of Taxation and to comply with all New Jersey tax laws.

I further certify the following as required by the Uniform Construction Code, N.J.A.C. 5:23-2.15(a)5: All required State, county, and local prior approvals, including such certification as the construction official may require, have been given or will be given prior to pemit issuance.

I understand that if any of the above statements are willfully false, I am subject to punishment.

Signature _____ Date _____

II. AGENT SECTION (to be completed if the applicant is not the owner in fee)

I hereby certify the following as required by the Uniform Construction Code, N.J.A.C. 5:23-2.15(d): the proposed work is authorized by the owner in fee; and I have been authorized by the owner in fee to make this application as his agent.

I further certify the following as required by the Uniform Construction Code, N.J.A.C. 5:23-2.15(a)5: All required State, county, and local prior approvals, including such certification as the construction official may require, have been given or will be given prior to permit issuance.

I agree to advise all contractors on this project that they are required to be registered with the New Jersey Division of Taxation and to comply with all New Jersey tax laws.

I understand that if any of the above statements are willfully false, I am subject to punishment.

(X) Check if contractor.

Agent Name Michael J McKiever

Address 7 South Tamarack Dr.

Brielle NJ 08730

Telephone 732 859-0314

Signature _____

III. ( ) LEAD HAZARD ABATEMENT: Include Homeowner or Building Owner Affidavit as per N.J.A.C. 5:23-2.15(b)4.

IV. ( ) HOME ELEVATION: Include Home Elevation Contractor Certification as per N.J.S.A. 52:27D-123.16.

CONSTRUCTION PERMIT

7/22/19

Date Issued
Control # C-19-002237
Permit # 19-1985

IDENTIFICATION Block: 671 Lot: 1.01 Qualifier

Work Site Location: 56 CHAMBERS BRIDGE RD. Brick Township, NJ

Owner in Fee: FEDERAL REALTY INVESTMENT TRUST % PO BOX 92129 (ALTUS GROUP SOUTHLAKE TX 76092
Telephone: (415) 722-3704

Contractor: MJM ELECTRIC INC
Address: 7 SOUTH TAMARK DRIVE BRIELLE NJ 08730
Telephone: (732) 859-0314
Lic. No. or Bldrs. Reg. No. 34EIO1271500
Federal Employee. No. 22-3485744

Is hereby granted permission to perform the following work:

- [x] BUILDING
- [ ] PLUMBING
- [ ] LEAD HAZARD ABATEMENT
- [x] ELECTRICAL
- [ ] FIRE PROTECTION
- [ ] DEMOLITION
- [ ] ELEVATOR DEVICES
- [ ] ASBESTOS ABATEMENT (Subchapter 8 only)
- [ ] OTHER

DESCRIPTION OF WORK:

SOLAR PANELS - LA FITNESS ...REINSTALL SOLAR

Note: If construction does not commence within one (1) year of date of issuance, or if construction ceases for a period of six (6) months, this permit is void.

Estimated Cost of Work $96,321

D. Drawbaugh 7/3/19
Construction Official Date

PAYMENTS (Office Use Only)

Building	$1,072
Electrical	$750
Plumbing	$0
Fire Protection	$0
Elevator Devices	$0
Other	$0.00
DCA Training Fee	$183
CO Fee	
Other	$0
Total	$2,005
Check No.	
Cash	$0
Credit	$0
Collected By	

+75
2,080

U.C.C. F170
equiv (rev 1/04)

1 WHITE - INSPECTOR 2 CANARY - OFFICE 3 PINK - TAX ASSESSOR 4 GOLD - APPLICANT

REQUIRED INSPECTIONS

Construction work must be inspected in accordance with the State Uniform Construction Code Regulations N.J.A.C. 5:23-2.18. This agency will carry out such periodic inspections during the progress of work as are necessary to insure that the work installed conforms with the requirements of the Uniform Construction Code.

The owner or other responsible person in charge of work must notify this agency when work is ready for any required inspections specified below. Requests for inspections must be made at least 24 hours prior to the time the inspection is desired. Inspections will be performed within three business days of the time for which they are requested. The work must not proceed in a manner which will preclude the inspection until it has been made and approval granted.

- [ ] Required inspections for all subcodes for one- and two-family dwellings are as follows:

1. The bottom of footing trenches before placement of footings, except that in cases of pile foundations, inspections shall be made in accordance with the requirements of the building subcode.
2. Foundations and all walls up to grade level prior to back filling.
3. All structural framing, connections, wall and roof sheathing and insulation; electrical rough wiring, panel and service installation; rough plumbing. The framing inspection shall take place after the rough electrical and plumbing inspections and after the installation of the heating, ventilation and /or air conditioning duct system. The insulation inspection shall be performed after all other subcode rough inspections and prior to the installation of any interior finish material.
4. Installation of all finished materials, sealings of exterior joints, plumbing piping, trim and fixtures; electrical wiring, devices and fixtures; mechanical systems equipment.

Additional required inspections for all subcodes of construction, for other than one- and two-family dwellings, are fire suppression systems, heat producing devices and Barrier Free subcode accessibility, if applicable.

- [ ] Required special inspections. The applicant by accepting the permit will be deemed to have consented to these requirements:

- [x] A final inspection is required for each applicable subcode area before a final Certificate of Occupancy or Approval may be issued. The final inspections include the installation of all interior and exterior finish materials, sealing of exterior joints, mechanical system and other required equipment; electrical wiring, devices and fixtures; plumbing pipes, trim and fixtures; tests required by any provision of the adopted subcodes, Barrier Free accessibility, if applicable; and verification of compliance with NJAC 5:23-3.5, "Posting structures".

- [x] A complete copy of released plans must be kept on the job site.

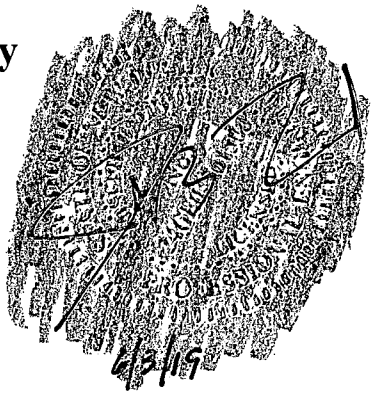
If you do not understand any of this information, please ask.

Larson Engineering, Inc.
1488 Bond Street, Suite 100
Naperville, IL 60563-6503
630.357.0540 Fax: 630.357.0164
www.larsonengr.com

Larson

Brick Plaza
110 Brick Plaza
Brick, NJ 08723

Structural Calculations
Roof Mounted Solar Array



Book 1 of 1
Calculation Release #2

Prepared for
Panel Claw, Inc.
North Andover, MA

TOWNSHIP OF BRICK
RELEASED FOR PERMIT

	INITIAL	DATE
Building Subcode	WAK	07/03/19
Plumbing Subcode		
Fire Subcode		
Electrical Subcode	PSC	7/2/19
Plan Reviewer		
Plans Released		
Construction Official		

FILE COPY

Larson Engineering, Inc.
Naperville, Illinois
Project Number 21180001.060
New Jersey COA No. 24GA-28066300
Joseph B. Tinder
Registration No. 24GE04761500

© 2019 Larson Engineering, Inc. All rights reserved.

FILE COPY

Table of Contents:

Appendix:

A. I.F.I PCM10-8: Wind Loads on the solar ballasted roof mount system 'Polar Bear 5 deg Gen IIIHD' of PanelClaw Inc.; March 03,2016

B. B. Building Code and Technical data

1.0 Project Information:

1.1 General:

Project Name: BRICK PLAZA REDEVELOPMENT
Project Locaton: 1 Brick Plaza
Brick, NJ, 08723

Racking System:	Polar Bear III HD	
Module:	Suntech	Pluto240-Wde
Module Tilt:	5.00	degrees
Module Width:	39.02	in.
Module Length:	65.55	in.
Module Area:	17.76	sq.ft.
Ballast Block Weight =	32.60	lbs.

1.2 Building Information:

	Height (ft)	Roof Measurement N/S (ft.)	Roof Measurement E/W (ft.)	Parapet Height (ft)	Pitch (deg)	Membrane Material	Coeff. of Friction (μ)
Roof 1	26.16	268	276	3	1	EPDM	0.54

1.3 Structural Design Information:

Building Code:	2015 IBC	
Risk Cat. :	II	
Basic Wind Speed (V) =	122	mph
Exposure Category:	B	
Ground Snow Load (Pg) =	20	
Is =	1	
Site Class:	D	
Short Period Spectral Resp. (5%) (Ss):	0.196	
1s Spectral Response (5%)(S1):	0.059	
Ie =	1	
Ip =	1	

2.0 Snow Load:

Snow Calculations per ASCE 7-10, Chapter 7

2.1 Snow Load Data:

Ground Snow Load (Pg) =	20.00	psf	*ASCE, Figure 7-1*
Exposure Factor (Ce) =	1.00		*ASCE, Table 7-2*
Thermal Factor (Ct) =	1.20		*ASCE,Table 7-3*
Importance Factor (Is) =	1		*(ASCE, Table 1.5-2)*

Flat Roof Snow Load (Pf) =	0.7*Pg*Ce*Ct*Is=	16.80	psf	(ASCE 7.3-1)
Min Snow Load for Low Slope Roof =	Pg*Is =	20.00	psf	(ASCE 7.3.4)

Snow Load on Array (SL_A) = 20.00 psf

$$SL_A$$

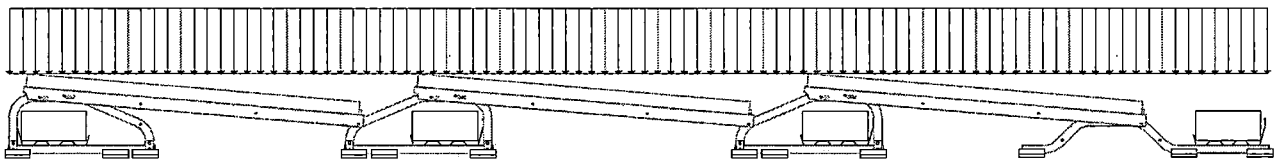


Fig. 2.1 - Uniform Roof Snow Load on Array

2.2 Snow Load Per Module:

Snow Load per Module (SL_M) = $Module\ Projected\ Area * SL_A$

Where;

Module Projected Area (Amp) = Module Area * Cos(Module Tilt)

Where;

Module Area = 17.76 sq.ft.

Module Tilt = 5.00 degrees

Amp = 17.69 sq.ft.

$$SL_M = A_{mp} * SL_A =$$ 353.86 lb

3.0 Wind Load:

Wind Analysis per ASCE 7-10- Wind Tunnel Procedure, Chapter 31

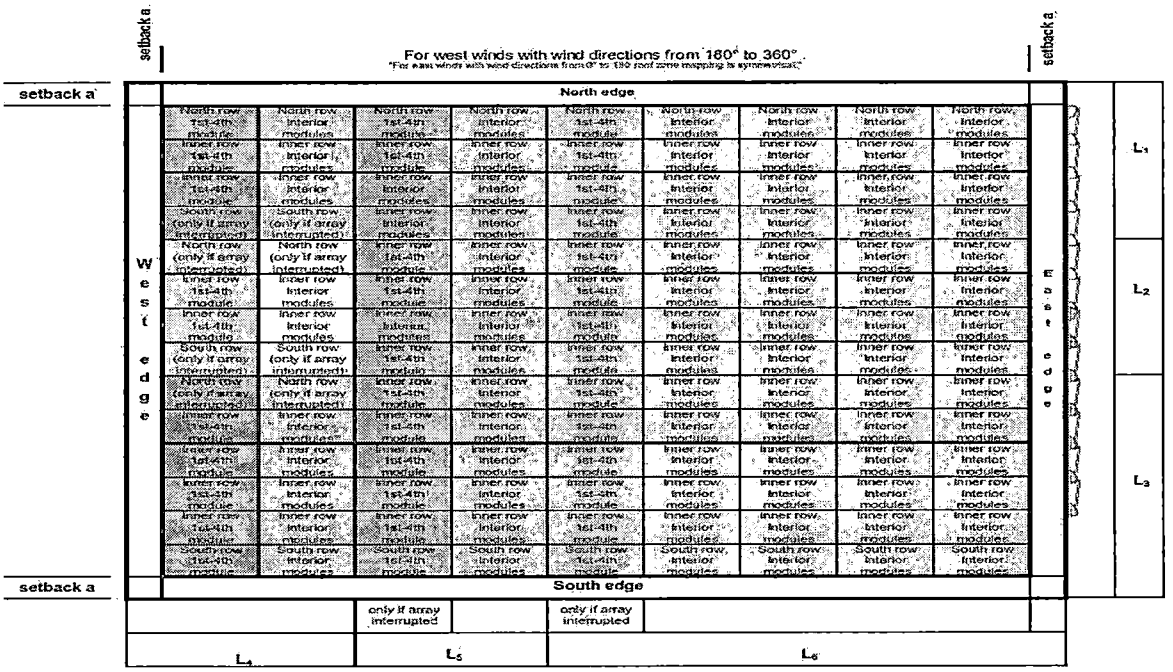
3.1 Wind Load Data:

Basic Wind Speed (Vult) =	122	mph	*(ASCE, Figure 26.5-1A)*
Exposure Category:	B		*(ASCE, Sec. 26.7.3)*
Topographic Factor (Kzt) =	1.00		*(ASCE, Fig. 26.8-1)*
Directionality Factor (Kd) =	0.85		*(ASCE, Table 26.6-1)*
Exposure Coefficient (Kz) =	0.7		*(ASCE, Table 27.3-1)*

MRI Reduction = 0.93 *(Eqn. C26.5-2)*

Velocity Pressure (qz) = 0.00256*Kz*Kzt*Kd*V^2*MRI^2 = 19.61 PSF *(ASCE, Eqn. 27.3-1)*

3.2 Roof / Array Zone Map:



Typical Roof Zone Mapping for West Winds with Directions from 180° to 360°

Roof Zone Map Dimenions per IFI Wind Tunnel Study							
Height (ft)	L1 (ft)	L2 (ft)	L3 (ft)	L4 (ft)	L5 (ft)	L6 (ft)	Velocity Pressure (qz)
26.3	55.94	42.49	169.58	55.94	42.49	177.58	19.61 PSF

3.3 Wind Design Equations:

$$WL_{uplift/module} = q_z A_m C_{fz,uplift}$$

$$WL_{sliding/module} = q_z A_m C_{fxy,sliding}$$

Where

qz= Velocity Pressure *(Ref. Pg. 3, Wind Load)*

Am= Module Area *(Ref. Pg. 1, Project Information)*

Cfz and Cfxy= Vary and related to wind zone map *(Proprietary Wind Tunnel Coefficients)*

4.0 Design Loads - Dead:

There are two categories of dead load used to perform the structural analysis of the PanelClaw racking system; ***Dead Load of the Array (DL A)*** *and* ***Dead Load of the Components (DL C)*** *.*

DLA is defined as the weight of the entire array including all of the system components and total ballast used on the array.

DLc is defined as the weight of the modules and the racking components within an array. The DLc does not include the ballast used to resist loads on this array.

4.1 Dead Load of the Arrays:

Max. Allowable Pressure on Roof = 10.00 psf

Array Information					Results			
Sub-Array No.	Numbers of modules	DLC (lbs.)	DLA (lbs.)	DLC (lbs.)/module	Sub-Array Area (Ft^2)	Sub-Array Roof Pressure (DLC) (psf)	Sub-Array Roof Pressure (DLA) (psf)	Acceptable?
1	44	2,619	4,607	60	956	2.74	4.82	Yes
2	111	6,609	11,890	60	2,407	2.75	4.94	Yes
3	14	867	1,649	62	309	2.80	5.33	Yes
4	305	18,201	25,764	60	6,595	2.76	3.91	Yes
5	10	616	1,203	62	218	2.83	5.52	Yes
6	57	3,455	5,085	61	1,240	2.79	4.10	Yes
7	23	1,397	2,016	61	495	2.82	4.07	Yes
8	60	3,590	5,220	60	1,307	2.75	3.99	Yes
Totals:	624	37,354	57,435					

Table 4.1 Array Dead Loads and Roof Pressures

4.0 Design Load - Dead (Cont.):

Racking System: Polar Bear III HD

4.2 Racking System Dead Load Calculation:

The array dead load is made up of three components; the racking assembly, ballast and module weights.

Array # 1

Component Weight:		**Quantity**
SOUTH SUPPORT=	1.85 lbs.	16
STANDARD SUPPORT=	2.30 lbs.	88
LONG BALLAST TRAY=	7.08 lbs.	10
MEDIUM BALLAST TRAY =	5.86 lbs.	0
SHORT BALLAST TRAY =	4.58 lbs.	49
CLAWS(2)=	3.88 lbs.	44
MECHANICAL ATTACHMENT=	1.72 lbs.	0
MA Bracket =	2.32 lbs.	0
Suntech - Pluto240-Wde =	43.65 lbs.	44
Ballast Weight:		
CMU Ballast Block =	32.60 lbs.	61

4.3 Module Assembly Dead Load Calculations Array 1:

The following calculation determines the nominal weight of a single module assembly. This value is used to calculate the required ballast for Wind Loads as shown in Section 6.1.

Single Module + Racking System Weights:

Nominal Assembly Weight

Components Array Dead Load (DLC) = 2619 lbs.

Module Assembly Dead Load (DLc) = Components Array Dead Load (DLC) / # Modules = 60 lbs.

5.0 Design Loads - Wind.

5.1.1 Global Wind Uplift Summary Table:

The necessity to add mechanical attachments can arise for several reasons. Building code requirements, roof load limits and array shape all may come into play when determining their need. The table below provides the mechanical attachment requirements for each sub-array within this project

Assumed Allowable Mechanical Attachment Strength = 300.00 lbs.

	Applied Load	Resisting Load			Code Check	
Sub-Array No.	W = Total Wind Uplift (lb)	DL = Total Dead Load (lb)	Quantity MA Provided	MA Capacity (lb)	Calculated Factor of Safety*	Check
1	4,159	4,607	0	0	1.85	OK
2	11,504	11,890	0	0	1.72	OK
3	1,208	1,649	0	0	2.28	OK
4	24,868	25,764	36	10,800	2.45	OK
5	761	1,203	0	0	2.63	OK
6	5,537	5,085	8	2,400	2.25	OK
7	1,735	2,016	4	1,200	3.09	OK
8	5,147	5,220	7	2,100	2.37	OK
Totals:	54,918 lbs.	57,435 lbs.	55	16,500 lbs.		

Table 5.1 Summary of Mechanical Attachment Requirements

* Back calculated factor of safety provided to determine factor of safety applied to dead load in lieu of 0.6 in ASCE 7-10 equation 7, BACK CALCLUATED SAFETY FACTOR= (DEAD LOAD+MECHANICAL ATTACHMENT)/(.6)WIND LOAD

5.0 Design Loads - Wind (Cont.)

5.1.2 Global Wind Shear Summary Table:

Assumed Allowable Mechanical Attachment Strength = 300.00 lbs.

	Applied Load		Resisting Loads			Code Check	
Sub-Array No.	Wu = Wind Uplift (lb)	Ws = Wind Shear (lb)	DL = Total Dead Load (lb)	MA Provided	MA Capacity (lb)	Calculated Factor of Safety*	Check
1	2,357	207	4,607	0	0	2.80	OK
2	7,298	640	11,890	0	0	2.34	OK
3	1,043	91	1,649	0	0	2.27	OK
4	18,918	1,659	25,764	36	10800	2.77	OK
5	653	57	1,203	0	0	2.64	OK
6	4,332	380	5,085	8	2400	2.48	OK
7	1,254	110	2,016	4	1200	3.68	OK
8	3,849	337	5,220	7	2100	2.73	OK
Totals:	39,703 lbs.	3,481 lbs.	57,435 lbs.	55	16,500 lbs.		

Table 5.2 Summary of Mechanical Attachment Requirements.

* Back calculated factor of safety provided to determine factor of safety applied to dead load in lieu of 0.6 in ASCE 7-10 equation 7, BACK CALCLUATED SAFETY FACTOR= (DEAD LOAD+MECHANICAL ATTACHMENT)/(((.6)WIND SHEAR/FRICTION)+(.6)WIND UPLIFT)

6.0 Design Loads - Downward:

6.1 Downward Wind Load Calculation:

$$WL_{in} = q_z * A_m * C_{fz} * \cos\theta$$

Where:

qz =	19.61 psf		*(Ref. Pg. 3, Wind Load)*
Am =	17.76 sq.ft.	*(Single Module Area)*	*(Ref. Pg. 1, Project Information)*
θ =	5.00 deg.		*(Ref. Pg. 1, Project Information)*
C_{fz} =	0.90	*(Inward)*	*(Proprietary Wind Tunnel Data)*
C_{fz} =	0.30	*(Inward with snow)*	(ASCE 7-10 figure 30.4-2A)

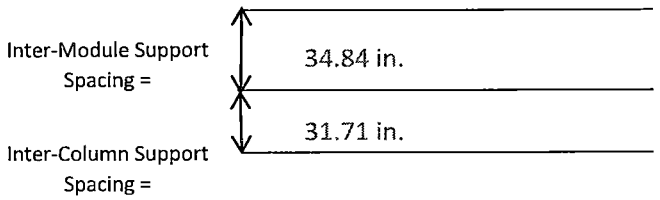
$WL_{in}\ (no\ snow)$ = 312 lbs./module

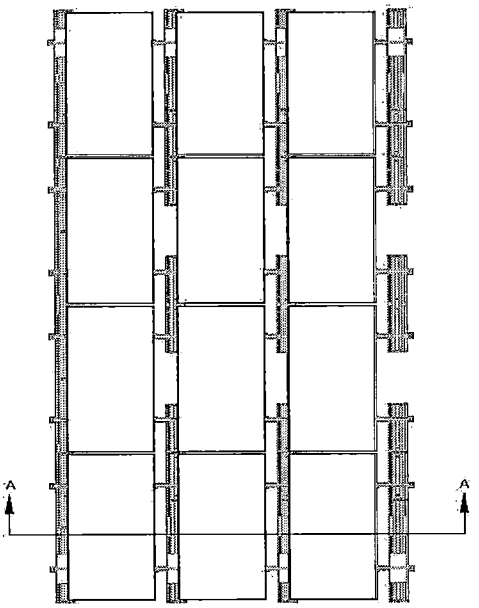
$WL_{in}(with\ snow)$ = 104 lbs./module

Contact Pad by Location:

A = Northern
B = Northern
C = Interior
D = Interior
E = Southern
F = Southern

6.2 Racking Dimensions for Point Loads:

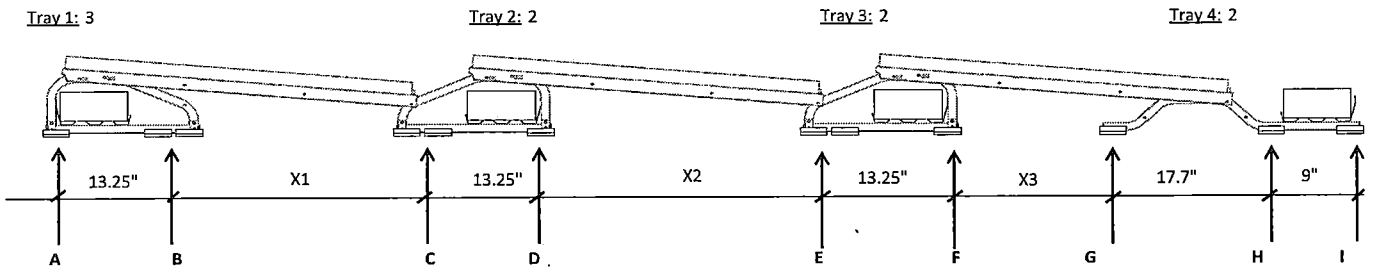




Typical Array Plan View
(Section A-A on Next Page)

6.0 Design Loads - Downward (CONT.):

6.2 Racking Dimensions for Point Loads (Cont.):



Section A-A

Distances Between Supports (Unless Noted):

X1 = 27.74 in.
X2 = 32.39 in.
X3 = 18.40 in.

6.3 Point Load Summary:

DLsys = 62 lbs./module
Total DL = (Varies on location and ballast quantity)
SLm = 354 lbs./module
Wlin (no snow) = 312 lbs./module
Wlin (with snow) = 104 lbs./module

Point Load Summary Table				
		load combinations (ASD)		
Location	Load	DL + SLm	DL + 0.6 X Wlin	DL + 0.75 X SLm + 0.75(0.6 X Wlin
Northern	A	85 lbs.	64 lbs.	79 lbs.
Northern	B	68 lbs.	47 lbs.	63 lbs.
Interior	C	115 lbs.	73 lbs.	104 lbs.
Interior	D	126 lbs.	84 lbs.	115 lbs.
Interior	E	115 lbs.	73 lbs.	104 lbs.
Interior	F	126 lbs.	84 lbs.	115 lbs.
Southern	G	35 lbs.	21 lbs.	31 lbs.
Southern	H	51 lbs.	37 lbs.	47 lbs.
Southern	I	51 lbs.	37 lbs.	47 lbs.
For Checking	Σ	770 lbs.	521 lbs.	708 lbs.

Table 7.1 Point Load Summary

Ballast Block Point Load Summary - (LB/Single Block Applied at Tray Location)					
Location		Point Loads (lb/single block) at each Tray Location			
		Tray 1	Tray 2	Tray 3	Tray 4
Northern	A	11 lbs.			
Northern	B	5 lbs.			
Interior	C		5 lbs.		
Interior	D		11 lbs.		
Interior	E			5 lbs.	
Interior	F			11 lbs.	
Southern	G				
Southern	H				8 lbs.
Southern	I				8 lbs.

7.0 Design Loads - Seismic

Seismic Calculations per ASCE 7-10, Chapter 11 - Seismic Design Criteria
Chapter 13 - Requirements for Nonstructural Components

7.1 Seismic Load Data:

Site Class:	D		(Ref. Pg. 1, Project Information)
Seismic Design Category:	B		(ASCE, Tables 11.6-1 and 11.6-2)
Short Period Spectral Resp. (5%) (Ss):	0.196		(Ref. Pg. 1, Project Information)
1s Spectral Response (5%)(S1):	0.059		(Ref. Pg. 1, Project Information)
Bldg. Seismic Imp. Factor (Ie) =	1		(ASCE, Table 1.5-2)
Site Coefficient (Fa) =	1.6		(ASCE, Table 11.4-1)
Site Coefficient (Fv) =	2.40		(ASCE, Table 11.4-2)
Adj. MCE Spec. Resp. (Short) (Sms)=	Fa*Ss =	0.3136	(ASCE, Eqn. 11.4-1)
Adj. MCE Spec. Resp. (1 sec.)(Sm1) =	Fv*S1 =	0.1416	(ASCE, Eqn. 11.4-2)
Short Period Spectral Response (Sds) =	2/3(Sms) =	0.2	(ASCE, Eqn. 11.4-3)
One Second Spectral Response (Sd1) =	2/3(Sm1) =	0.09	(ASCE, Eqn. 11.4-4)
Component Seismic Imp. Factor (Ip) =	1		(ASCE, Sec. 13.1.3)
Repsonse Modification Factor (Rp) =	2.5		(ASCE, Table 13.6-1)
Amplification Factor (ap) =	1		(ASCE, Table 13.6-1)

7.2 Seismic Design Equations:

Lateral Force $(F_p) = \frac{0.4 a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)}\left(1 + 2\left(\frac{z}{h}\right)\right)$ (ASCE, Eqn. 13.3-1)

$F_{PLmin} = 0.3 S_{DS} I_p W_p$ *(ASCE, Eqn. 13.3-3)*

$F_{PLmax} = 1.6 S_{DS} I_p W_p$ *(ASCE, Eqn. 13.3-2)*

$Vertical\ Force\ (F_{pv}) = \pm[0.20 S_{DS} W_p]$ *(ASCE, Eqn. 12.4-4)*

.ateral Resisting Force (FRL)* = ') (mu)(Wp)] (Factored Load, ASD)

Vertical Resisting Force (FRV) = 0.6*Wp (Factored Load, ASD)

* Per SEAOC PV1 - 2012 - Frictional resistance due to the components weight may be used to resist lateral forces caused by seismic loads. The coefficient of friction for the roof material must be reduced by 30%.

7.0 Design Loads - Seismic (cont.)

7.3 Lateral Seismic Force Check:

The necesity to add mechanical attachments can arrise for several reasons. Building code requirements, roof load limits and array shape all may come into play when determining their need. The table below provides the mechanical attachment requirements for each sub-array within this project.

Assumed Allowable Mechanical Attachment Lateral Strength = 300.00 lbs.

Nomenclature:

W_P = Sub-Array Weight
F_{PL} = Lateral Seismic Force
F_{RL} = Lateral Seismic Resisting Force

Array Information		Lateral Force Verification				Results	
Sub-Array No.	Wp (lbs.)	F_{PL} (lbs.)	F_{RL} (lbs.)	0.7 F_{PL} - F_{RL} (lbs.)	MA's Required*	MA's Provided	Acceptable
1	4,607	462	994	-670	0	0	Yes
2	11,890	1,193	2,565	-1,730	0	0	Yes
3	1,649	166	356	-240	0	0	Yes
4	25,764	2,585	5,558	-3,748	0	36	Yes
5	1,203	121	260	-175	0	0	Yes
6	5,085	510	1,097	-740	0	8	Yes
7	2,016	202	435	-293	0	4	Yes
8	5,220	524	1,126	-760	0	7	Yes
Totals:	57,435 lbs.	5,764 lbs.	12,391 lbs.	-8,356 lbs.	0	55	

Table 7.1 -Summary of Mechanical Attachment Requirements

* MA's Required = 0.7 Fpl-FRl/MA strength

7.0 Design Loads - Seismic (Cont.)

7.4 Vertical Seismic Force Check:

Assumed Allowable Mechanical Attachment Vertical Strength = 300 lbs.

Nomenclature:

W_P = Sub-Array Weight
F_{PV} = Vertical Seismic Force
F_{RV} = Vertical Seismic Resisting Force

Array Information		Vertical Force Verification				Results	
Array No.	Wp (lbs.)	F_{PV} (lbs.)	F_{RV} (lbs.)	0.7 F_{PV} - F_{RV} (lbs.)	Required MA's	Total MA's Provided	Acceptable
1	4,607	193	2,764	-2,629	0	0	Yes
2	11,890	497	7,134	-6,786	0	0	Yes
3	1,649	69	990	-941	0	0	Yes
4	25,764	1,077	15,458	-14,704	0	36	Yes
5	1,203	50	722	-687	0	0	Yes
6	5,085	213	3,051	-2,902	0	8	Yes
7	2,016	84	1,210	-1,151	0	4	Yes
8	5,220	218	3,132	-2,979	0	7	Yes
Totals:	57,435 lbs.	2,402 lbs.	34,461 lbs.	-32,780 lbs.	0	55	

Table7.2 - Summary of Mechanical Attachment Requirements

* MA's Required = 0.7 FPV - FRV/MA strength

Appendix A

Hochschule Aachen

I.F.I. Institut
für Industrieaerodynamik GmbH
Institute at Aachen University of Applied Sciences

Wetterauer Straße 120
52074 Aachen, Germany

Phone: +49 (0) 241/5679705-0
Fax: +49 (0) 241/5679705-10
Email: info@if-aachen.de

Client: PanelClaw Inc., North Andover, MA 01845, USA

Report No.: PCM10-8

Date: 03/03/2016

Wind loads on the solar ballasted roof mount system „Polar Bear 5deg Gen III HD" of PanelClaw Inc.

Design wind loads for uplift and sliding according to the ASCE 7-10

Reviewed by:

Dr.-Ing. Th. Kray

(Head of department of PV wind loading)

Prepared by:

Dipl.-Ing. (FH) J. Paul

(Consultant for wind loading)

Management:
Dipl.-Ing. B. Konrath, Dr.-Ing. R.-D. Usb
Scientific Advisory Board:
Prof. Dr.-Ing. R. Grundmann, Prof. Dr.-Ing. H. Fiedler, Prof. Dr.-Ing. Th. Heyden
Founded by:
Prof. Dr.-Ing. H.J. Gerhardt, Prof. Dr.-Ing. G. Kramer

Sparkasse Aachen
IBAN: DE25 3905 0000 0047 4400 03
BIC: AACSDE33
Amtsgericht Aachen
HRB 4515
VAT No.: DE121662741

Accredited Test and Certification Body, European Notified Product Certification Body 1302 according to CPR
Certified according to ISO 9001
EADIS approved laboratory for wind tunnel testing of buildings and structures., Testing Agency License Number TA 24830

Wind tunnel tests were conducted on the "Polar Bear 5deg Gen III HD" solar ballasted roof mount system of PanelClaw Inc. The tests were performed at I.F.I. Institut für Industrieaerodynamik GmbH (Institute for Industrial Aerodynamics), Institute at the Aachen University of Applied Sciences in accordance with the test procedures described in ASCE 7-10, chapter 31 and in accordance with the specifications of ASCE 49-12.

The array assembly and the corresponding geometric dimensions of the solar ballasted roof mount system "Polar Bear 5deg Gen III HD" with tilt angles of 5deg are depicted in Figure 1 and Figure 2.

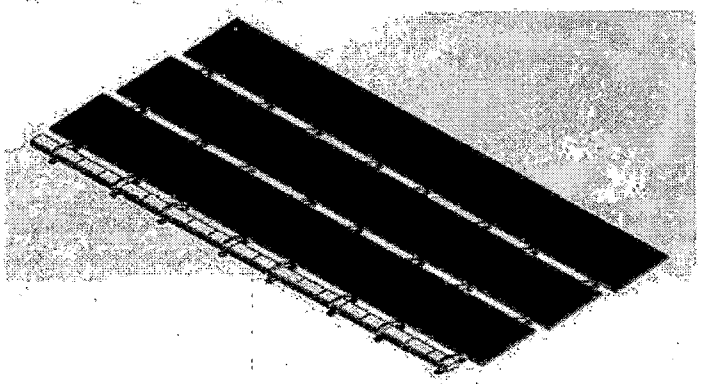


Figure 1: Array assembly of the solar ballasted roof mount system "Polar Bear 5deg Gen III HD" in landscape orientation with a module tilt angle of 5deg

Testing was carried out with a surface roughness of the fetch in the boundary layer wind tunnel equivalent to open country (Exposure C according to ASCE/SEI 7-10) and for a total of 12 building configurations with sharp roof edges and with parapets of varying height. Figure 3 shows one flat-roofed building model with parapet including the view of the fetch in the large I.F.I. boundary layer wind tunnel. In Figure 4 a close-up of the Polar Bear 5deg Gen III HD solar ballasted roof mount system is depicted. Pressure coefficients were provided for normalized loaded areas of varying size, five roof zones and eight array zones. Loaded areas scale with building dimensions and are valid for flat-roofed buildings with a minimum setback of 1.0m from the roof edges. The pressure coefficients may be multiplied by the design velocity pressure q_z, determined depending on the wind zone, the exposure category

and the roof height in accordance with the American standard ASCE/SEI 7-10 to determine the wind loads on the solar system.

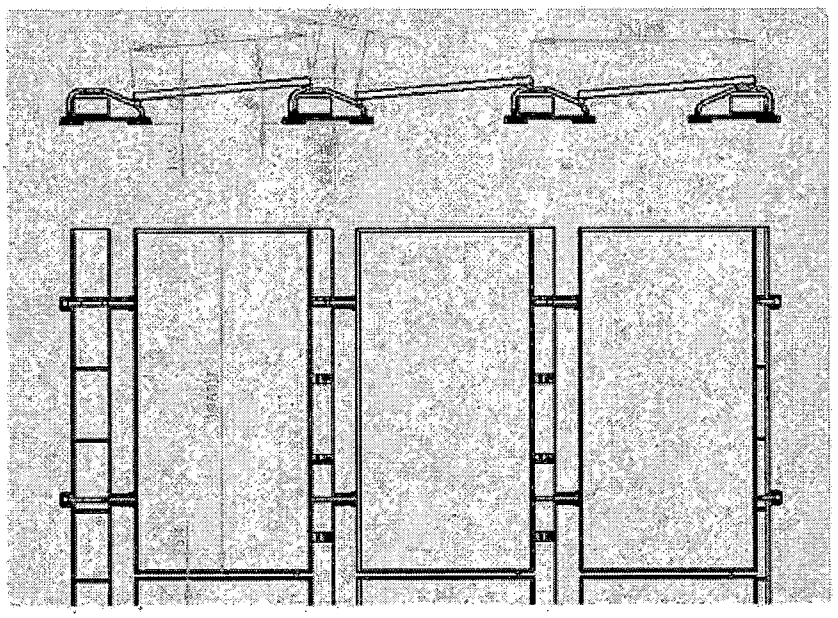


Figure 2: Geometric dimensions of the array assembly of the solar ballasted roof mount system "Polar Bear 5deg Gen III HD" in landscape orientation with a module tilt angle of 5deg

The test results are likely to be appropriate for upwind Exposures B, C and D on flat-roofed buildings, assuming use in compliance with ASCE/SEI 7-10, Chapter 30.1.3. From these results it is possible to calculate the design ballast for uplift and sliding safety - sliding of solar elements occurs if the aerodynamic lift has decreased the down force due to deadweight sufficiently so that the drag forces are larger than the frictional forces - on flat roofs with pitch angles up to 7°.

The pressure coefficients were determined for a set-up where wind direction 0° corresponded to wind blowing on the north façade of the flat-roofed building. However, the results may be applied if the main axis of the array is not skewed more than 15° with the building edges.

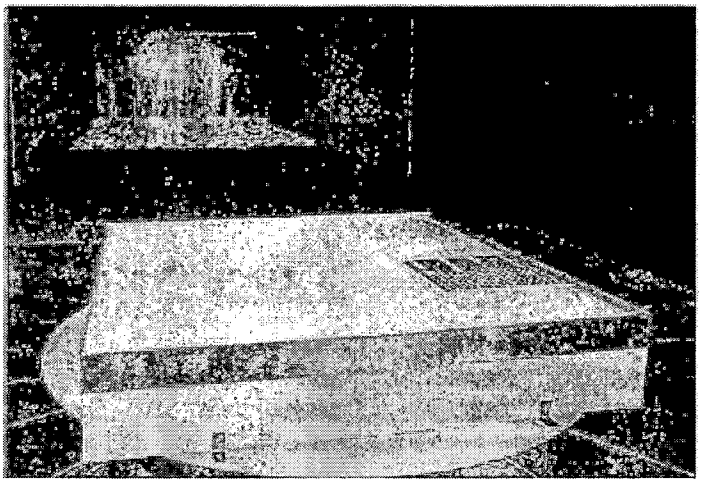


Figure 3: Wind tunnel model of the flat-roofed building with the solar ballasted roof mount system "Polar Bear 5deg Gen III HD in landscape orientation" with a module tilt angle of 5deg mounted on the turntable including view of the fetch in the large I.F.I. boundary layer wind tunnel; 8x12 array in the south-east roof portion

The present design loads for wind actions apply without restriction to solar arrays deployed on low-rise buildings as defined in section 26.2 of ASCE 7-10. The wind tunnel testing also applies to buildings higher than 18.3 m (60 ft) which are considered rigid. A building may always be assumed as rigid if it is at least as wide as it is high.

The pressure coefficients determined from the wind tunnel tests show that the system in question needs very little ballast in the array interior. The sliding and uplift loads exerted by the wind on the modules are small due to the arrangement in rows. Higher loads were only observed in array corners and along exposed edges of the array, and these have to be taken into account. On the basis of the measurements carried out, this may be done directly by increasing the ballast locally on the array edges or corners as well as – in the arrangement of rows and space between the rows – by largely redistributing the ballast. However, in the latter case, the structural requirements for the load transfer through the support system are higher, as a corner module lifted off the roof has to be held in place by the adjacent modules.

As stated in ASCE 7-10, section C 26.1.2 buildings with site locations that have channelling effects or wakes from upwind obstructions, buildings with unusual or irregular geometric shape and buildings with unusual response characteristics require use of recognized literature for documentation pertaining to wind effects.

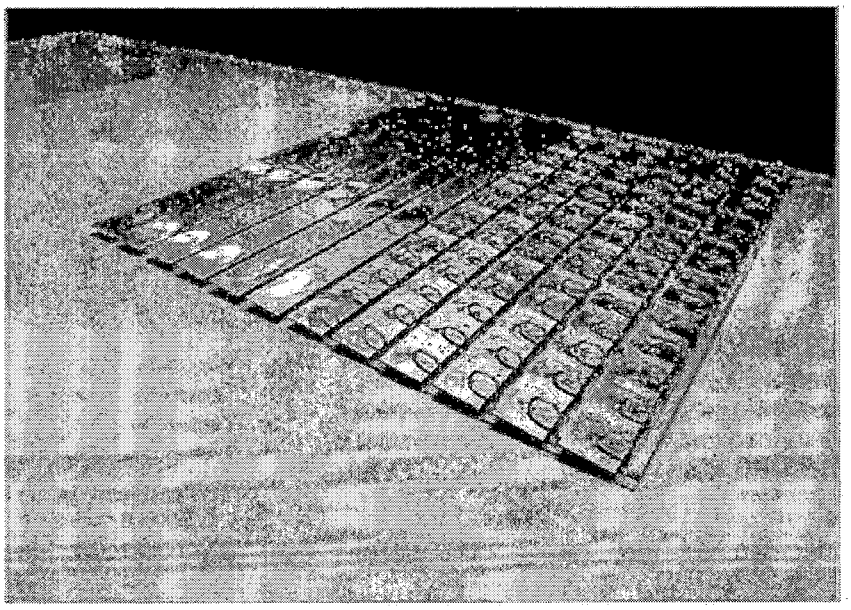


Figure 4: Close-up of the 8x12 array of the solar ballasted roof mount system "Polar Bear 5deg Gen III HD in landscape orientation" with a module tilt angle of 5deg

Details of the wind tunnel testing and of the analysis can be found in the long version of the report PCM10-6-4.

Appendix B

Chapter 13
SEISMIC DESIGN REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS

13.1 GENERAL

13.1.1 Scope

This chapter establishes minimum design criteria for nonstructural components that are permanently attached to structures and for their supports and attachments. Where the weight of a nonstructural component is greater than or equal to 25 percent of the effective seismic weight, W, of the structure as defined in Section 12.7.2, the component shall be classified as a nonbuilding structure and shall be designed in accordance with Section 15.3.2.

13.1.2 Seismic Design Category

For the purposes of this chapter, nonstructural components shall be assigned to the same seismic design category as the structure that they occupy or to which they are attached.

13.1.3 Component Importance Factor

All components shall be assigned a component importance factor as indicated in this section. The component importance factor, I_p, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.
2. The component conveys, supports, or otherwise contains toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released.
3. The component is in or attached to a Risk Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.
4. The component conveys, supports, or otherwise contains hazardous substances and is attached to a structure or portion thereof classified by the authority having jurisdiction as a hazardous occupancy.

All other components shall be assigned a component importance factor, I_p, equal to 1.0.

13.1.4 Exemptions

The following nonstructural components are exempt from the requirements of this section:

1. Furniture (except storage cabinets as noted in Table 13.5-1).
2. Temporary or movable equipment.
3. Architectural components in Seismic Design Category B other than parapets supported by bearing walls or shear walls provided that the component importance factor, I_p, is equal to 1.0.
4. Mechanical and electrical components in Seismic Design Category B.
5. Mechanical and electrical components in Seismic Design Category C provided that the component importance factor, I_p, is equal to 1.0.
6. Mechanical and electrical components in Seismic Design Categories D, E, or F where all of the following apply:
   a. The component importance factor, I_p, is equal to 1.0;
   b. The component is positively attached to the structure;
   c. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and either
      i. The component weighs 400 lb (1,780 N) or less and has a center of mass located 4 ft (1.22 m) or less above the adjacent floor level; or
      ii. The component weighs 20 lb (89 N) or less or, in the case of a distributed system, 5 lb/ft (73 N/m) or less.

13.1.5 Application of Nonstructural Component Requirements to Nonbuilding Structures

Nonbuilding structures (including storage racks and tanks) that are supported by other structures shall be designed in accordance with Chapter 15. Where Section 15.3 requires that seismic forces be determined in accordance with Chapter 13 and values for R_p are not provided in Table 13.5-1 or 13.6-1, R_p shall be taken as equal to the value of R listed in Section 15. The value of a_p shall be determined in accordance with footnote a of Table 13.5-1 or 13.6-1.

shown that the component is inherently rugged by comparison with similar seismically qualified components. Evidence demonstrating compliance with this requirement shall be submitted for approval to the authority having jurisdiction after review and acceptance by a registered design professional.

2. Components with hazardous substances and assigned a component importance factor, I_p, of 1.5 in accordance with Section 13.1.3 shall be certified by the manufacturer as maintaining containment following the design earthquake ground motion by (1) analysis; (2) approved shake table testing in accordance with Section 13.2.5; or (3) experience data in accordance with Section 13.2.6. Evidence demonstrating compliance with this requirement shall be submitted for approval to the authority having jurisdiction after review and acceptance by a registered design professional.

13.2.3 Consequential Damage

The functional and physical interrelationship of components, their supports, and their effect on each other shall be considered so that the failure of an essential or nonessential architectural, mechanical, or electrical component shall not cause the failure of an essential architectural, mechanical, or electrical component.

13.2.4 Flexibility

The design and evaluation of components, their supports, and their attachments shall consider their flexibility as well as their strength.

13.2.5 Testing Alternative for Seismic Capacity Determination

As an alternative to the analytical requirements of Sections 13.2 through 13.6, testing shall be deemed as an acceptable method to determine the seismic capacity of components and their supports and attachments. Seismic qualification by testing based upon a nationally recognized testing standard procedure, such as ICC-ES AC 156, acceptable to the authority having jurisdiction shall be deemed to satisfy the design and evaluation requirements provided that the substantiated seismic capacities equal or exceed the seismic demands determined in accordance with Sections 13.3.1 and 13.3.2.

13.2.6 Experience Data Alternative for Seismic Capacity Determination

As an alternative to the analytical requirements of Sections 13.2 through 13.6, use of experience data shall be deemed as an acceptable method to determine the seismic capacity of components and their supports and attachments. Seismic qualification by experience data based upon nationally recognized procedures acceptable to the authority having jurisdiction shall be deemed to satisfy the design and evaluation requirements provided that the substantiated seismic capacities equal or exceed the seismic demands determined in accordance with Sections 13.3.1 and 13.3.2.

13.2.7 Construction Documents

Where design of nonstructural components or their supports and attachments is required by Table 13.2-1, such design shall be shown in construction documents prepared by a registered design professional for use by the owner, authorities having jurisdiction, contractors, and inspectors. Such documents shall include a quality assurance plan if required by Appendix 11A.

13.3 SEISMIC DEMANDS ON NONSTRUCTURAL COMPONENTS

13.3.1 Seismic Design Force

The horizontal seismic design force (F_p) shall be applied at the component's center of gravity and distributed relative to the component's mass distribution and shall be determined in accordance with Eq. 13.3-1:

$$F_p = \frac{0.4a_p S_{DS} W_p}{\left(\frac{R_p}{I_p}\right)}\left(1 + 2\frac{z}{h}\right) \qquad (13.3\text{-}1)$$

F_p is not required to be taken as greater than

$$F_p = 1.6 S_{DS} I_p W_p \qquad (13.3\text{-}2)$$

and F_p shall not be taken as less than

$$F_p = 0.3 S_{DS} I_p W_p \qquad (13.3\text{-}3)$$

where

F_p = seismic design force
S_{DS} = spectral acceleration, short period, as determined from Section 11.4.4
a_p = component amplification factor that varies from 1.00 to 2.50 (select appropriate value from Table 13.5-1 or 13.6-1)
I_p = component importance factor that varies from 1.00 to 1.50 (see Section 13.1.3)
W_p = component operating weight

The effects of seismic relative displacements shall be considered in combination with displacements caused by other loads as appropriate.

13.4 NONSTRUCTURAL COMPONENT ANCHORAGE

Nonstructural components and their supports shall be attached (or anchored) to the structure in accordance with the requirements of this section and the attachment shall satisfy the requirements for the parent material as set forth elsewhere in this standard.

Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity. A continuous load path of sufficient strength and stiffness between the component and the supporting structure shall be provided. Local elements of the structure including connections shall be designed and constructed for the component forces where they control the design of the elements or their connections. The component forces shall be those determined in Section 13.3.1, except that modifications to F_p and R_p due to anchorage conditions need not be considered. The design documents shall include sufficient information relating to the attachments to verify compliance with the requirements of this section.

13.4.1 Design Force in the Attachment

The force in the attachment shall be determined based on the prescribed forces and displacements for the component as determined in Sections 13.3.1 and 13.3.2, except that R_p shall not be taken as larger than 6.

13.4.2 Anchors in Concrete or Masonry.

13.4.2.1 Anchors in Concrete

Anchors in concrete shall be designed in accordance with Appendix D of ACI 318.

13.4.2.2 Anchors in Masonry

Anchors in masonry shall be designed in accordance with TMS 402/ACI 530/ASCE 5. Anchors shall be designed to be governed by the tensile or shear strength of a ductile steel element.

EXCEPTION: Anchors shall be permitted to be designed so that the attachment that the anchor is connecting to the structure undergoes ductile yielding at a load level corresponding to anchor forces not greater than their design strength, or the minimum design strength of the anchors shall be at least 2.5 times the factored forces transmitted by the component.

13.4.2.3 Post-Installed Anchors in Concrete and Masonry

Post-installed anchors in concrete shall be prequalified for seismic applications in accordance with ACI 355.2 or other approved qualification procedures. Post-installed anchors in masonry shall be prequalified for seismic applications in accordance with approved qualification procedures.

13.4.3 Installation Conditions

Determination of forces in attachments shall take into account the expected conditions of installation including eccentricities and prying effects.

13.4.4 Multiple Attachments

Determination of force distribution of multiple attachments at one location shall take into account the stiffness and ductility of the component, component supports, attachments, and structure and the ability to redistribute loads to other attachments in the group. Designs of anchorage in concrete in accordance with Appendix D of ACI 318 shall be considered to satisfy this requirement.

13.4.5 Power Actuated Fasteners

Power actuated fasteners in concrete or steel shall not be used for sustained tension loads or for brace applications in Seismic Design Categories D, E, or F unless approved for seismic loading. Power actuated fasteners in masonry are not permitted unless approved for seismic loading.

EXCEPTION: Power actuated fasteners in concrete used for support of acoustical tile or lay-in panel suspended ceiling applications and distributed systems where the service load on any individual fastener does not exceed 90 lb (400 N). Power actuated fasteners in steel where the service load on any individual fastener does not exceed 250 lb (1,112 N).

13.4.6 Friction Clips

Friction clips in Seismic Design Categories D, E, or F shall not be used for supporting sustained loads in addition to resisting seismic forces. C-type beam and large flange clamps are permitted for hangers provided they are equipped with restraining straps equivalent to those specified in NFPA 13, Section 9.3.7. Lock nuts or equivalent shall be provided to prevent loosening of threaded connections.

laterally braced to the building structure. Such bracing shall be independent of any ceiling lateral force bracing. Bracing shall be spaced to limit horizontal deflection at the partition head to be compatible with ceiling deflection requirements as determined in Section 13.5.6 for suspended ceilings and elsewhere in this section for other systems.

EXCEPTION: Partitions that meet all of the following conditions:

1. The partition height does not exceed 9 ft (2,740 mm).
2. The linear weight of the partition does not exceed the product of 10 lb (0.479 kN) times the height (ft or m) of the partition.
3. The partition horizontal seismic load does not exceed 5 psf (0.24 kN/m^2).

13.5.8.2 Glass

Glass in glazed partitions shall be designed and installed in accordance with Section 13.5.9.

13.5.9 Glass in Glazed Curtain Walls, Glazed Storefronts, and Glazed Partitions

13.5.9.1 General

Glass in glazed curtain walls, glazed storefronts, and glazed partitions shall meet the relative displacement requirement of Eq. 13.5-1:

$$\Delta_{allow} \geq 1.25 I_p D_p \qquad (13.5\text{-}1)$$

or 0.5 in. (13 mm), whichever is greater where:

Δ_{allow} = the relative seismic displacement (drift) at which glass fallout from the curtain wall, storefront wall, or partition occurs (Section 13.5.9.2)

D_p = the relative seismic displacement that the component must be designed to accommodate (Section 13.3.2.1). D_p shall be applied over the height of the glass component under consideration

I_p = the importance factor determined in accordance with Section 11.5.1

EXCEPTION:

1. Glass with sufficient clearances from its frame such that physical contact between the glass and frame will not occur at the design drift, as demonstrated by Eq. 13.5-2, need not comply with this requirement:

$$D_{clear} \geq 1.25 D_p \qquad (13.5\text{-}2)$$

where

D_{clear} = relative horizontal (drift) displacement, measured over the height of the glass panel under consideration, which causes initial glass-to-frame contact. For rectangular glass panels within a rectangular wall frame

$D_{clear} = 2c_1\left(1+\frac{h_g c_2}{b_g c_1}\right)$ where

h_g = the height of the rectangular glass panel

b_g = the width of the rectangular glass panel

c_1 = the average of the clearances (gaps) on both sides between the vertical glass edges and the frame

c_2 = the average of the clearances (gaps) top and bottom between the horizontal glass edges and the frame

2. Fully tempered monolithic glass in Risk Categories I, II, and III located no more than 10 ft (3 m) above a walking surface need not comply with this requirement.
3. Annealed or heat-strengthened laminated glass in single thickness with interlayer no less than 0.030 in. (0.76 mm) that is captured mechanically in a wall system glazing pocket, and whose perimeter is secured to the frame by a wet glazed gunable curing elastomeric sealant perimeter bead of 0.5 in. (13 mm) minimum glass contact width, or other approved anchorage system need not comply with this requirement.

13.5.9.2 Seismic Drift Limits for Glass Components

Δ_{allow}, the drift causing glass fallout from the curtain wall, storefront, or partition shall be determined in accordance with AAMA 501.6 or by engineering analysis.

13.6 MECHANICAL AND ELECTRICAL COMPONENTS

13.6.1 General

Mechanical and electrical components and their supports shall satisfy the requirements of this section. The attachment of mechanical and electrical components and their supports to the structure shall meet the requirements of Section 13.4. Appropriate coefficients shall be selected from Table 13.6-1.

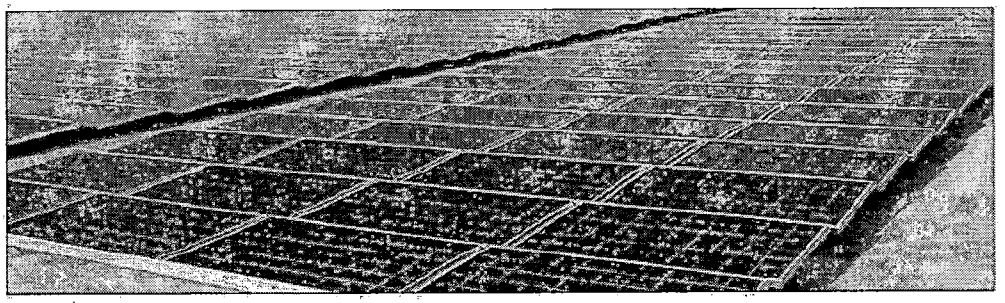
EXCEPTION: Light fixtures, lighted signs, and ceiling fans not connected to ducts or piping, which are supported by chains or otherwise suspended from the structure, are not required to satisfy the seismic

Table 13.6-1 Seismic Coefficients for Mechanical and Electrical Components

Mechanical and Electrical Components	a_p[a]	R_p[b]
Air-side HVAC, fans, air handlers, air conditioning units, cabinet heaters, air distribution boxes, and other mechanical components constructed of sheet metal framing	2.5	6.0
Wet-side HVAC, boilers, furnaces, atmospheric tanks and bins, chillers, water heaters, heat exchangers, evaporators, air separators, manufacturing or process equipment, and other mechanical components constructed of high-deformability materials	1.0	2.5
Engines, turbines, pumps, compressors, and pressure vessels not supported on skirts and not within the scope of Chapter 15	1.0	2.5
Skirt-supported pressure vessels not within the scope of Chapter 15	2.5	2.5
Elevator and escalator components	1.0	2.5
Generators, batteries, inverters, motors, transformers, and other electrical components constructed of high deformability materials	1.0	2.5
Motor control centers, panel boards, switch gear, instrumentation cabinets, and other components constructed of sheet metal framing	2.5	6.0
Communication equipment, computers, instrumentation, and controls	1.0	2.5
Roof-mounted stacks, cooling and electrical towers laterally braced below their center of mass	2.5	3.0
Roof-mounted stacks, cooling and electrical towers laterally braced above their center of mass	1.0	2.5
Lighting fixtures	1.0	1.5
Other mechanical or electrical components	1.0	1.5
Vibration Isolated Components and Systems[c]		
Components and systems isolated using neoprene elements and neoprene isolated floors with built-in or separate elastomeric snubbing devices or resilient perimeter stops	2.5	2.5
Spring isolated components and systems and vibration isolated floors closely restrained using built-in or separate elastomeric snubbing devices or resilient perimeter stops	2.5	2.0
Internally isolated components and systems	2.5	2.0
Suspended vibration isolated equipment including in-line duct devices and suspended internally isolated components.	2.5	2.5
Distribution Systems		
Piping in accordance with ASME B31, including in-line components with joints made by welding or brazing	2.5	12.0
Piping in accordance with ASME B31, including in-line components, constructed of high or limited deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings	2.5	6.0
Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing	2.5	9.0
Piping and tubing not in accordance with ASME B31, including in-line components, constructed of high- or limited-deformability materials, with joints made by threading, bonding, compression couplings, or grooved couplings	2.5	4.5
Piping and tubing constructed of low-deformability materials, such as cast iron, glass, and nonductile plastics	2.5	3.0
Ductwork, including in-line components, constructed of high-deformability materials, with joints made by welding or brazing[d]	2.5	9.0
Ductwork, including in-line components, constructed of high- or limited-deformability materials with joints made by means other than welding or brazing	2.5	6.0
Ductwork, including in-line components, constructed of low-deformability materials, such as cast iron, glass, and nonductile plastics	2.5	3.0

STRUCTURAL ENGINEERS ASSOCIATION OF CALIFORNIA

STRUCTURAL SEISMIC REQUIREMENTS AND COMMENTARY FOR ROOFTOP SOLAR PHOTOVOLTAIC ARRAYS



By

SEAOC Solar Photovoltaic Systems Committee

Report ***SEAOC PV1-2012***
August 2012

Requirements and Commentary

1. Structural performance objectives

Consistent with the intent of the IBC 2009 (Section 101.3), PV arrays and their structural support systems shall be designed to provide life-safety performance in the Design Basis Earthquake ground motion and the design wind event. Life-safety performance means that PV arrays are expected not to create a hazard to life, for example as a result of breaking free from the roof, sliding off the roof's edge, exceeding the downward load-carrying capacity of the roof, or damaging skylights, electrical systems, or other rooftop features or equipment in a way that threatens life-safety. For life-safety performance, damage, structural yielding, and movement are acceptable, as long as they do not pose a threat to human life.

Commentary: The Design Basis Earthquake ground motion in ASCE 7 has a return period of approximately 500 years, and design wind loads (considering load factors) equate to a return period of approximately 300 years for Risk Category I structures, 700 years Risk Category II, and 1700 years Risk Category IV. (In ASCE 7-10, the importance factor is built into the return period for wind). For more frequent events (e.g., events with a 50-year return period), it may be desirable to design the PV array to remain operational; these requirements do not cover but do not preclude using more stringent design criteria.

These requirements are applicable to all Occupancy Categories. However if the PV array or any rooftop component adjacent to the array have $I_p > 1.0$, post-earthquake operability of the component must be established consistent with Section 13.1.3 of ASCE 7-10.

2. Types of arrays

For the purposes of these structural requirements, rooftop PV panel support systems shall be classified as follows:

- **Unattached (ballast-only)** arrays are not attached to the roof structure. Resistance to wind and seismic forces is provided by weight and friction.
- **Attached roof-bearing** arrays are attached to the roof structure at one or more attachment points, but they also bear on the roof at support points that may or may not occur at the same locations as attachment points. The load path for upward forces is different from that for downward forces. These systems may include additional weights (ballast) as well.
- **Fully-framed arrays** (stanchion systems) are structural frames that are attached to the roof structure such that the load path is the same for both upward and downward forces.

Commentary: Sections 1, 2, and 3 of this document are relevant to all rooftop arrays. Section 4 addresses attached arrays. Sections 5, 6, 7, and 9 address unattached arrays. Section 8 applies to attached or unattached roof-bearing arrays.

Attached arrays can include those with flexible tethers as well as more rigid attachments. Both types of attachments are to be designed per Section 4.

The documents AC 428 (ICC-ES 2011b) and AC 365 (ICC-ES 2011a) provide criteria for other types of PV systems, which are not covered in the specific provisions herein. AC 428 addresses systems flush-mounted on building roofs or walls, and free-standing (ground-mounted) systems. AC 365 addresses building-integrated systems such as roof panels, shingles, or adhered modules.

3. Building seismic-force-resisting system

For PV arrays added to an existing building, the seismic-force-resisting system of the building shall be checked per the requirements of Chapter 34 of IBC 2009.

Commentary: Per Sections 3403.4 and 3404.4 of IBC 2009, if the added mass of the PV array does not increase the seismic mass tributary to any lateral-force-resisting structural element by more than 10%, the seismic-force-resisting system of the building is permitted to remain unaltered. Sections 3403.3 and 3404.3 also require that the gravity structural system of the building be evaluated if the gravity load to any existing element is increased by more than 5%.

4. Attached arrays

PV support systems that are attached to the roof structure shall be designed to resist the lateral seismic force F_p specified in ASCE 7-10 Chapter 13.

In the computation of F_p for attached PV arrays, an evaluation of the flexibility and ductility capacity of the PV support structure is permitted to be used to establish values of a_p and R_p. If the lateral strength to resist F_p relies on attachments with low deformation capacity, R_p shall not be taken greater than 1.5.

For low-profile arrays for which no part of the array extends more than 4 feet above the roof surface, the value of a_p is permitted to be taken equal to 1.0, the value of R_p is permitted to be taken equal to 1.5, and the ratio a_p/R_p need not be taken greater than 0.67.

Commentary: In the computation of F_p for attached low-profile solar arrays, a_p is commonly taken as 1.0 and R_p is commonly taken as 1.5, which are the values prescribed for "other mechanical or electrical components" in Table 13.6-1 of ASCE 7-10. An evaluation of the flexibility and ductility capacity of the PV support structure can be made according to the definitions in ASCE-7 for rigid and flexible components, and for high-, limited-, and low-deformability elements and attachments.

The provisions of this section focus on low-profile roof-bearing systems. Other types of systems are to be designed by other code requirements that are applicable. Solar carport type structures on the roof of a building are to be designed per the applicable requirements of Sections 13.1.5 and 15.3 of ASCE 7-10.

For attached roof-bearing systems, friction is permitted to contribute in combination with the design lateral strength of attachments to resist the lateral force F_p when all of the following conditions are met:

- The maximum roof slope at the location of the array is less than or equal to 7 degrees (12.3 percent);
- The height above the roof surface to the center of mass of the solar array is less than the smaller of 36 inches and half the least plan dimension of the supporting base of the array; and
- R_p shall not exceed 1.5 unless it is shown that the lateral displacement behavior of attachments is compatible with the simultaneous development of frictional resistance.

The resistance of slack tether attachments shall not be combined with frictional resistance.

The contribution of friction shall not exceed $(0.9–0.2S_{DS})(0.7\mu)W_{up}$, where W_{up} is the component weight providing normal force at the roof bearing locations, and μ is the coefficient of friction at the bearing interface.

The coefficient μ shall be determined by friction testing per the requirements in Section 8, except that for Seismic Design Categories A, B, or C, μ is permitted to be taken equal to 0.4 if the roof surface consists of mineral-surfaced cap sheet, single-ply membrane, or sprayed foam membrane, and is not gravel, wood, or metal.

Commentary: When frictional resistance is used to resist lateral seismic forces, the applicable seismic load combination of ASCE 7 results in a normal force of $(0.9–0.2S_{DS})W_{up}$. This normal force is multiplied by the friction coefficient, which is reduced by a 0.7 factor, based on the consensus judgment of the committee to provide conservatism for frictional resistance. The factor of 0.7 does not need to be applied to the frictional properties used in evaluating unattached systems per Section 9.

If the design lateral strength of attachments is less than 25% of F_p, the array shall meet the requirements of Section 6 with $\Delta_{up,v}$ taken equal to 6 inches.

Commentary: The requirement above is intended to prevent a designer from adding relatively few attachments to an otherwise unattached array for the purpose of not providing the minimum seismic design displacement.

5. Unattached arrays

Unattached (ballast-only) arrays are permitted when all of the following conditions are met:

- The maximum roof slope at the location of the array is less than or equal to 7 degrees (12.3 percent).
- The height above the roof surface to the center of mass of the solar array is less than the smaller of 36 inches and half the least plan dimension of the supporting base of the array.
- The array is designed to accommodate the seismic displacement determined by one of the following procedures:
  - Prescriptive design seismic displacement per Sections 6, 7, and 8;
  - Nonlinear response history analysis per Sections 6, 8, and 9; or
  - Shake table testing per Sections 6, 8, and 9.

Appendix B

Commentary: The provisions of Section 13.4 of ASCE 7 require that "Components and their supports shall be attached (or anchored) to the structure..." and that "Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity."

This document recommends conditions for which exception can be taken to the above requirements; Appendix A indicates recommended changes to ASCE 7-10. Until such a change is made in ASCE 7, the provisions of this document can be considered an alternative method per IBC 2009 Section 104.11.

6. Design of unattached arrays to accommodate seismic displacement

For unattached (ballast-only) arrays, accommodation of seismic displacement shall be afforded by providing the following minimum separations to allow sliding:

Condition	Minimum Separation
Between separate solar arrays of similar construction	$0.5(I_e)\Delta_{MPV}$
Between a solar array and a fixed object on the roof or solar array of different construction	$(I_e)\Delta_{MPV}$
Between a solar array and a roof edge with a qualifying parapet	$(I_e)\Delta_{MPV}$
Between a solar array and a roof edge without a qualifying parapet	$1.5(I_e)\Delta_{MPV}$

Where Δ_{MPV} is the design seismic displacement of the array relative to the roof, as computed per the requirements herein, I_e is the importance factor for the building, and I_p is the component importance factor for the solar array or the component importance factor for other rooftop components adjacent to the solar array, whichever is greatest. For the purposes of this requirement, a parapet is "qualifying" if the top of the parapet is not less than 6 inches above the center of mass of the solar array, and also not less than 24 inches above the adjacent roof surface.

Commentary: The factor of 0.5, based on judgment, accounts for the likelihood that movement of adjacent arrays will tend to be synchronous and that collisions between arrays do not necessarily represent a life-safety hazard. The factor of 1.5 is added, by judgment of the committee, to provide extra protection against the life safety hazard of an array sliding off the edge of a roof. A qualifying parapet (and the roof slope change that may be adjacent to it) is assumed to partly reduce the probability of an array sliding off the roof justifying the use of Δ_{MPV} rather than $1.5\Delta_{MPV}$. Calculation of the parapet's lateral strength to resist the array movement is not required by this document.

Each separate array shall be interconnected as an integral unit such that for any vertical section through the array, the members and connections shall have design strength to resist a total horizontal force across the section, in both tension and compression, equal to the larger of $0.133S_{DS}W_I$ and $0.1W_I$.

Where:

W_I = the weight of the portion of the array, including ballast, on the side of the section that has smaller weight.

The horizontal force shall be applied to the array at the level of the roof surface, and shall be distributed in plan in proportion to the weight that makes up W_I. The computation of strength across the section shall account for any eccentricity of forces.

Elements of the array that are not interconnected as specified shall be considered structurally separate and shall be provided with the required minimum separation.

Commentary: The interconnection force of $0.133S_{DS}W_I$ or $0.1W_I$ accounts for the potential that frictional resistance to sliding will be different under some portions of the array as a result of varying normal force and actual instantaneous values of μ for a given roof surface material.

The roof structure of the building shall be capable of supporting the factored gravity load of the PV array displaced from its original location up to Δ_{MPV} in any horizontal direction.

Roof drainage shall not be obstructed by movement of the PV array and ballast up to Δ_{MPV} in any horizontal direction.

Electrical systems and other items attached to arrays shall be flexible and designed to accommodate the required minimum separation in a manner that meets code life-safety performance requirements. Details of providing slackness or movement capability to electrical wiring shall be included on the permit drawings for the solar installation.

Commentary: This document provides only structural requirements. The design must also meet applicable requirements of the governing electrical codes.

The minimum clearance around solar arrays shall be the larger of the seismic separation defined herein and minimum separation clearances required for firefighting access.

Commentary: Section 605 of the *International Fire Code* (ICC 2012) provides requirements for firefighting access pathways on rooftops with solar arrays, based on the recommendations in CAL FIRE-OSFM (2008). For commercial and large residential flat roofs (which are the roof type on which unattached arrays are feasible) requirements include 4 feet to 6 feet clearance around the perimeter of the roof, maximum array dimensions of 150 feet between access pathways, and minimum clearances around skylights, roof hatches, and standpipes.

Note that the clearance around solar arrays is the larger of the two requirements for seismic and firefighting access. The separation distances do not need to be added together.

7. Prescriptive design seismic displacement for unattached arrays

Δ_{MPV} is permitted to be determined by the prescriptive procedure below if all of the following conditions are met:

- I_e per ASCE 7-10 Chapter 13 is equal to 1.0 for the solar array and for all rooftop components adjacent to the solar array.
- The maximum roof slope at the location of the array is less than or equal to 3 degrees (5.24 percent).
- The manufacturer provides friction test results, per the requirements in Section 8, which establish a coefficient of friction between the PV support system and the roof surface of not less than 0.4. For Seismic Design Categories A, B, or C, friction test results need not be provided if the roof surface consists of mineral-surfaced cap sheet, single-ply membrane, or sprayed foam membrane, and is not gravel, wood, or metal.

Δ_{MPV} shall be taken as follows:

Seismic Design Category	Δ_{MPV}
A, B, C	6 inches
D, E, F	$[(S_{DS} - 0.4)^2] * 60$ inches, but not less than 6 inches

Commentary: The prescriptive design seismic displacement values conservatively bound nonlinear analysis results for solar arrays on common roofing materials. The formula is based on empirically bounding applicable analysis results, not a theoretical development. The PV Committee concluded that limits on S_{DS} or building height are not needed as a prerequisite to using the prescriptive design seismic displacement.

8. Friction testing

The coefficient of friction used in these requirements shall be determined by experimental testing of the interface between the PV support system and the roofing surface it bears on. Friction tests shall be carried out for the general type of roof bearing surface used for the project under the expected worst-case conditions, such as wet conditions versus dry conditions. The tests shall conform to applicable requirements of ASTM G115, including the report format of section 11. An independent testing agency shall perform or validate the friction tests and provide a report with the results.

The friction tests shall be conducted using a sled that realistically represents, at full scale, the PV panel support system, including materials of the friction interface and the flexibility of the support system under lateral sliding. The normal force on the friction surface shall be representative of that in typical installations. Lateral force shall be applied to the sled at the approximate location of the array mass, using displacement controlled loading that adequately captures increases and decreases in resistive force. The loading velocity shall be between 0.1 and 10 inches per second. If stick-slip behavior is observed, the velocity shall be adjusted to minimize this behavior. Continuous electronic recording shall be used to measure the lateral resistance. A minimum of three tests shall be conducted, with each test moving the sled a minimum of three inches under continuous movement. The force used to calculate the friction coefficient shall be the average force measured while the sled is under continuous movement. The friction tests shall be carried out for the general type of roofing used for the project.

Commentary: Because friction coefficient is not necessarily constant with normal force or velocity, the normal force is to be representative of typical installations and the velocity is to be less than or equal to that expected for earthquake movement. A higher velocity of loading could over-predict frictional resistance. Lateral force is to be applied under displacement control to be able to measure the effective dynamic friction under movement. Force-controlled loading, including inclined plane tests, only captures the static friction coefficient and does not qualify.

Friction tests are to be applicable to the general type of roofing used for the project, such as a mineral-surfaced cap sheet or a type of single-ply membrane material such as EPDM, TPO, or PVC. It is not envisioned that different tests would be required for different brands of roofing or for small differences in roofing type or condition.

For solar arrays on buildings assigned to Seismic Design Category D, E, or F where rooftops are subject to significant potential for frost or ice that is likely to reduce friction

Appendix B

between the solar array and the roof, the building official at their discretion may require increased minimum separation, further analysis, or attachment to the roof.

Commentary: A number of factors affect the potential that frost on a roof surface will be present at the same time that a rare earthquake occurs, and whether such frost increases the sliding displacement of an array. These factors include:

-the potential for frost to occur on a roof based on the climate at the site, whether the building is heated, and how well the roof is insulated

-the number of hours per day and days per year that frost is present

-whether solar modules occur above, and shield from frost, the roof surface around the support bases of the PV array

9. Nonlinear response history analysis or shake table testing for unattached arrays

For unattached solar arrays not complying with the requirements of Section 7, the design seismic displacement corresponding to the Design Basis Earthquake shall be determined by nonlinear response history analysis or shake table testing using input motions consistent with ASCE 7-10 Chapter 13 design forces for non-structural components on a roof.

The analysis model or experimental test shall account for friction between the array and the roof surface, and the slope of the roof. The friction coefficient used in analysis shall be based on testing per the requirements in Section 8.

For response history analysis or derivation of shake table test motions, either of the following input types are acceptable: (a) spectrally matched rooftop motions, or (b) rooftop response to appropriately scaled design basis earthquake ground motions applied to the base of a dynamically representative model of the building supporting the PV array being considered.

(a) Spectrally Matched Rooftop Motions: This method requires a suite of not less than three appropriate roof motions, spectrally matched to broadband design spectra per AC 156 (ICC-ES 2010) Figure 1 and Section 6.5.1. The spectrum shall include the portion for T > 0.77 seconds (frequency < 1.3 Hz) for which the spectrum is permitted to be proportional to $1/T$.

(b) Appropriately Scaled Design Basis Earthquake Ground Motions Applied to Building Model: This method requires a suite of not less than three appropriate ground motions, scaled in conformance with the requirements of Chapter 16 of ASCE 7-10 over at least the range of periods from the initial building period, T_i to a minimum of 2.0 seconds or $1.5T_i$ whichever is greater. The building is permitted to be modeled as linear elastic. The viscous damping used in the response history analysis shall not exceed 5 percent.

Each roof or ground motion shall have a total duration of at least 30 seconds and shall contain at least 20 seconds of strong shaking per AC 156 Section 6.5.2.

For analysis, a three-dimensional analysis shall be used, and the roof motions shall include two horizontal components and one vertical component applied concurrently.

Commentary: Nonstructural components on elevated floors or roofs of buildings experience earthquake shaking that is different from the corresponding ground-level shaking. Roof-level shaking is filtered through the building so it tends to cause greater horizontal spectral acceleration at the natural period(s) of vibration of the building and smaller accelerations at other periods.

For input method (a), AC 156 is referenced because it provides requirements for input motions to nonstructural elements consistent with ASCE 7 Chapter 13 design forces. The requirement added in this document to include the portion of the spectrum with T > 0.77 seconds is necessary to make the motions appropriate for predicting sliding displacement, which can be affected by longer period motions.

The target spectra defined in AC 156 are broadband spectra, meaning that they envelope potential peaks in spectral acceleration over a broad range of periods of vibration, representing a range of different buildings where nonstructural components could be located. Comparative analytical studies (Maffei *et al.* 2012) have shown that the use of broadband spectra provides a conservative estimate of the sliding displacement of solar arrays compared to unmodified roof motions.

For input method (b), appropriately scaled Design Basis Earthquake ground motions are applied to the base of a building analysis model that includes the model of the solar array on the roof. In such a case, the properties of the building analysis model should be appropriately bracketed to cover a range of possible building dynamic properties (Walters 2010, Walters 2012).

Because friction resistance depends on normal force, vertical earthquake acceleration can also affect the horizontal movement of unattached components, so inclusion of a vertical component is required.

For shake table testing, it is permitted to conduct a three-dimensional test using two horizontal components and one

Appendix B

vertical component, or a two-dimensional test with one horizontal component and one vertical component. In all cases the components of motion shall be applied concurrently.

Shake table tests shall apply the minimum of high-pass filtering to the input motions necessary for testing facility equipment capacities. Filtering shall be such that the resulting PV array displacements are comparable to those analytically computed for unfiltered input motions. If the input motions are high-pass filtered or if two-dimensional tests are conducted, the tests shall be supplemented with analytical studies of the tests to calibrate the influential variables and three dimensional analyses to compute the seismic displacement for unfiltered input motions.

Commentary: For some input motions and shake table facilities, input records may need to be high-pass filtered (removing some of the low-frequency content of the record) so that the shake-table movement does not exceed the table's displacement capacity. If filtering of motions is needed, it should be done in such a way as to have as little effect as possible on the resulting sliding displacement. Comparative analyses should be conducted to determine the effect of filtering on sliding displacement, after which unfiltered motions should be used in the analysis to determine the design seismic displacement.

If the shake table tests are two-dimensional, the tests should be used to calibrate comparable two-dimensional analyses, after which three-dimensional analyses should be used to determine the design seismic displacement.

If at least seven roof motions are used, the design seismic displacement is permitted to be taken as 1.1 times the *average* of the peak displacement values (in any direction) from the analyses or tests. If fewer than seven roof motions are used, the design seismic displacement shall be taken as 1.1 times the *maximum* of the peak displacement values from the analyses or tests.

Resulting values for Δ_{MPV} shall not be less than 50% of the values specified in Section 6, unless lower values are validated by independent Peer Review.

Commentary: The factor of 1.1 used in defining the design seismic displacement is to account for the random uncertainty of response for a single given roof motion. This uncertainty is assumed to be larger for sticking/sliding response than it is for other types of non-linear response considered in structural engineering. The factor is chosen by judgment.

Analytical and experimental studies of the seismic response of unattached solar arrays are reported by Schellenberg *et al.* (2012).

Notation

a_p = component amplification factor (per ASCE 7)

F_p = component horizontal seismic design force (per ASCE 7)

I_e = seismic importance factor for the building (per ASCE 7)

I_p = component importance factor (per ASCE 7)

R_p = component response modification factor (per ASCE 7)

S_{DS} = design 5%-damped spectral acceleration parameter at short periods (per ASCE 7)

T = fundamental period

W_1 = total weight of the array, including ballast, on the side of the section (being checked for interconnection strength) that has smaller weight

W_{pr} = component weight providing normal force at the roof bearing locations

Δ_{MPV} = design seismic displacement of the array relative to the roof

μ = coefficient of friction at the bearing interface between the roof surface and the solar array

Appendix B

ENGINEERING PERMIT APPLICATION

RECEIVING CLERK _____

PERMIT # _____

BLOCK 677 **LOT** 1.01 **ADDRESS** 1 Brick PLAZA

IDENTIFICATION:

1. WORK SITE ADDRESS 1 Brick PLAZA Brick NJ
2. APPLICANT Federal Realty Investment trust
3. NAME OF OWNER IN FEE Federal Realty Investment Trust
   ADDRESS PO Box 92129 Southlake TX 76092
   PHONE 415-722-3704 EMAIL bkapper@safarienergy.com
4. PRINCIPAL CONTRACTOR MJM Electric INC
   ADDRESS 7 South Tamarack Dr Brielle NJ 08730
   PHONE 732 859-0314 EMAIL mike@mjmelectricnj.com
5. ARCHITECT OR ENGINEER French + Parrillo
   ADDRESS 1600 RT 34 Wall NJ 07719
   PHONE 732-312-9800 EMAIL _____
6. RESPONSIBLE PERSON FOR WORK Michael J McKiever
   ADDRESS 7 South Tamarack Dr Brielle NJ 08730
   PHONE 732 859-0314 EMAIL mike@mjmelectricnj.com

FEE SUMMARY:

APPLICATION FEE	$ _____
REVIEW FEE	$ _____
INSPECTION FEE	$ _____
OTHER _____	$ _____
BOND(S)	$ _____
TOTAL	$ _____

SPECIAL CONDITIONS:

OCEAN COUNTY SOILS _____

DRAINAGE EASEMENTS _____

UTILITY EASEMENTS _____

CONSERVATION EASEMENTS _____

FEMA REQUIREMENTS _____

D.E.P. PERMITS _____

BOARD APPROVAL: ☐ PB ☐ ZB

APPLICATION NUMBER _____

APPROVED DATE _____

PROJECT DESCRIPTION:

☐ GRADING/CLEARING ☐ ROAD OPENING ☐ SOIL REMOVAL / FILL

☐ RETAINING WALL ☐ POOL ☐ BULKHEAD / DOCK ☐ DWELLING

☐ TREE REMOVAL ☐ COMMERCIAL SITE MAINTENANCE

☒ DESCRIPTION PV Panel Re-installation

ENGINEERING REVIEW:

DATE RECEIVED _____ DATE REJECTED _____ DATE APPROVED _____ INITIALS _____