

March 7, 2024 Mr. Paul Budge Diversi-Tech Corp - IntegraRack PO Box 910758 St. George, UT 84791

Subject: Compression, Horizontal, and Uplift Load Testing on the Universal L Foot Bracket (PN IR-DMLF2000) & IR-T1 No Penetration Tile Roof Bracket (IR-FCTR1500)

Dear Mr. Budge,

Please find included our test reports for the compression load test, horizontal load test, and combined uplift load testing of the Universal L Foot Bracket (PN IR-DMLF2000) & IR-T1 No Penetration Tile Roof Bracket (IR-FCTR1500) performed at our laboratory at 941 S. Park Lane, Tempe, AZ on 10/04/2023. The solar panels were installed on the tile roof using a total of 4 brackets

The compression load test was performed using dead weight provided by water filled plastic jugs that were weighed on our Instron 5985 test machine and had an average weight of 45.31 lbf. Test loads up to 815.58 lbf, equivalent to 38.00 psf force applied to the solar panels, were applied by evenly distributing the dead weight on the solar panel. Brackets were inspected before, during, and after the load test. Under load the brackets deflected downwards towards the roof but did not come into contact with the tile. Once the weight was removed the brackets were inspected and found to have lifted back to their original position and no visual permanent damage was noted. Test run details are shown in the table below.

	COMPRESSION TEST LOAD INFORMATION									
TEST LOAD 1: 11 Jugs = 498.41 lb			bf = 23.22 psf	TEST LOAD 2	17 Jugs = 770.27 lbf = 35.88 psf					
TEST LOAD 3: 18 Jugs = 815.58 lb		bf = 38.00 psf								
	COMPRESSION TEST LOAD BRACKET AND PANEL VISUAL DEFLECTION OBSERVATIONS									
NO.	NO LOAD - INITIAL VISUAL BRACKET SPACING		AT LOAD 1 (498.41 lbf) VISUAL BRACKET SPACING		AT LOAD 2 (770.27 lbf) VISUAL BRACKET SPACING					
1	No co	ontact	No contact		No contact					
2	No co	ontact	No contact		No contact					
3	No contact		No contact		No contact					
4	No contact		No contact		No contact					

The horizontal load test was conducted using a Weightronic Digital Dynamometer (Model OCS-Y) and chain hoist. A horizontal load of at least 500 lbf was applied at the center of the crossbeam that was attached to the panel brackets. The test specimen held the load and no damage or permanent deformation was noted as shown in the test observations table shown below.

	HORIZONTAL LOAD TEST TO > 500 lbf - VISUAL TEST OBSERVATIONS								
	тілі	TIAL	UNDER TEST LOAD (500 lbf)		AFTER LOAD REMOVAL				
NO.	BRACKET DEFORMATION	PANEL DEFORMATION	BRACKET DEFORMATION	PANEL DEFORMATION	BRACKET DEFORMATION	PANEL DEFORMATION			
1	None	None	Moderate	Moderate	None	None			
2	None	None	Moderate	Moderate	None	None			
3	None	None	Moderate	Moderate	None	None			
4	None	None	Moderate	Moderate	None	None			

The uplift load test was conducted using a Weightronic Digital Dynamometer (Model OCS-Y) and chain hoist. An uplift load of 710 lbf, equivalent to a 33.08 psf uplift force evenly applied to the solar panels, was applied at the center of the crossbeam that was attached to the four panel brackets. The test specimen held the load and no damage or permanent deformation of the test brackets was noted as shown in the test observations table shown below.

	UPLIFT TENSILE LOAD TO 710 lbf - VISUAL TEST OBSERVATIONS								
	INIT	TAL	UNDER UPLIFT TE	EST LOAD (710 lbf)	AFTER LOAD REMOVAL				
NO.	BRACKET DEFORMATION	PANEL DEFORMATION	BRACKET PANEL DEFORMATION DEFORMATION		BRACKET DEFORMATION	PANEL DEFORMATION			
1	None	None	Moderate	Moderate	None	None			
2	None	None	Moderate	Moderate	None	None			
3	None	None	Moderate	Severe	None	None			
4	None	None	Moderate	Moderate	None	None			

Test reports with additional details, photos, and sketches of the test setup and load points have been attached.

Respectfully submitted, **PHOENIX NATIONAL LABORATORIES, INC.**

The

Kyle Fleege, P.E. Project Manager / Mechanical Engineer Phoenix National Laboratories Ph: 1.602.431.8887 kyle@pnltest.com www.pnltest.com





Compression Load Test Ceramic Tile Roof

						Page 1 of 3	
CLIENT			CLIENT PR	OJECT REF. NO.	CLIE	ENT ORDER NO.	
	Diversi-Tech Corp	oration	Bracket Tes	t - Vertical Load		per S.A.	
MATE	RIAL SUBMITTED BY	PNL PROJECT NO	. S.O. NO.	PNL LAB NO.	TEST DATE	REPORT DATE	
	Client	26-231261	001	ML845913	10/04/202	3 10/13/2023	
		SAMF	LE DESCRIPTION			TECHNICIANS	
Tile	roof w/ Universal L	. Foot Bracke	et & IR-T1 No Pe	enetration Tile Roof	Bracket	TR, MC, DG	
		TEST	DATA & EQUIPM	ENT INFORMATION			
	TEMPERATURE:	88 °	F±3°F	HUMIC	DITY:	15%	
	TEST SPECIMEN SIZE:	Tile roof: 39.3	75 in. x 78.500 in.	TEST SPECIMEN A	AREA: 21.465 ft ²		
	COMPRESSION TYPE:	Fixed weight; applied with Water Jugs		AVERAGE FORCE PER JUG:		45.31 lbf	
В	RACKET COMPONENT 1:	Universal L Foot Bracket		BRACKET PART N	0.1:	. 1: IR-DMLF2000	
В	RACKET COMPONENT 2:	IR-T1 No Penetra	tion Tile Roof Bracket	BRACKET PART N	IR-FCTR1500		
		CON	IPRESSION TEST L	OAD INFORMATION			
	TEST LOAD 1:	11 Jugs = 498.4	1 lbf = 23.22 psf	TEST LOAD 2:	17 Jugs =	= 770.27 lbf = 35.88 psf	
	TEST LOAD 3:	18 Jugs = 815.58	3 lbf = 38.00 psf				
	В	RACKET AND	PANEL VISUAL D	EFLECTION OBSERV	TIONS		
NO.	NO LOAD - INITIAL VISI BRACKET SPACING		LOAD 1 - VISUAL ACKET SPACING	AT LOAD 2 - BRACKE SPACING	т	AT LOAD 3 - VISUAL SPACING	
1	No contact No		No contact	No contact		No contact	
2 No contact No contact No contact		No contact					
3 No contact No contact No contact		No contact					
4	No contact		No contact	No contact		No contact	

REMARKS:

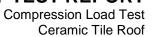
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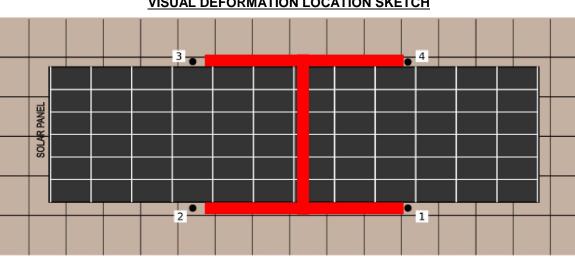
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CLIENT		CLIENT PROJECT REF. NO.		CLIENT	ORDER NO.		
Diversi-Tech Corp	oration	Bracket Te	st - Vertical Load	ре	r S.A.		
MATERIAL SUBMITTED BY	PNL PROJECT NO.	S.O. NO.	PNL LAB NO.	TEST DATE	REPORT DATE		
Client	26-231261	001	ML845913	10/04/2023	10/13/2023		
	SAMPLE	DESCRIPTION			TECHNICIANS		
Tile roof w/ Universal L	- Foot Bracket	& IR-T1 No F	Penetration Tile Ro	of Bracket	TR, MC, DG		
	TEST PROCEDURE/DESCRIPTION						
to ensure there was no contact betw between the tile and bottom of the b randomly selected and weighted to the test specimen. After the first loa and then 18 jugs. At 18 jugs the ga	The test specimen consisted of the solar panels, brackets, railing and the simulation tile roof. The bracket locations were visually examined for gap spacing o ensure there was no contact between the roof tile and the bracket. At each location a sheet of paper was slid beneath the bracket to verify open spacing between the tile and bottom of the bracket. After the initial inspection the compressive load was applied using plastic jugs filled with water. Four jugs were andomly selected and weighted to determine an average weight per jug of 45.31 lbf. Load was applied evenly by even distribution of 11 water jugs across he test specimen. After the first load was applied, the gaps between the brackets and tile roof were examined. Additional load was applied with 17 jugs and then 18 jugs. At 18 jugs the gap between the bracket and the roof was too tight to fit the sheet of paper underneath due to geometry of the tile roof bout the bracket was not in contact with the roof. After the final load test, all the weights were removed and the test specimen was visually examined for another papert damage or deforation.						
DEA	D WEIGHT & DEFL	ECTION MEASU	IREMENT EQUIPMENT	INFORMATION			
EQUIPMENT MODEL:	Instron 5985 UT	M [SN 1246]	CALIBRATION I	DATE:	07/25/2023		
LOAD CELL:	2 kN (449.6 lbf)	[SN 138082]	CALIBRATION I	DATE:	07/25/2023		
EQUIPMENT MODEL:	EQUIPMENT MODEL: Mitutoyo Digital Caliper [SN 14199376] CALIBRATION DATE: 10/04/2023						
	D	EAD WEIGHT M	EASUREMENTS				

	DEAD WEIGHT MEASUREMENTS							
NO. 1 (lbf) NO. 2 (lbf) NO. 3 (lbf) NO. 4 (lbf) AVERAGE (lbf)								
45.45	45.65	44.69	45.46	45.31				



VISUAL DEFORMATION LOCATION SKETCH

Bracket/Panel Gap Spacing Check

Compression Load Test Tile Roof



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CLIENT		CLIENT PROJ	ECT REF. NO.	CLIENT	ORDER NO.
Diversi-Tech Corporation		Bracket Test - Vertical Load		ре	er S.A.
MATERIAL SUBMITTED BY	PNL PROJECT NO.	S.O. NO.	PNL LAB NO.	TEST DATE	REPORT DATE
Client	26-231261	001	ML845912	10/04/2023	10/13/2023
	TECHNICIANS				
Tile roof w/ Universa	TR, MC, DG				

PHOTOS



PHOTO 1: Overview of solar panel and tile roof deck - before tests



PHOTO 2: Typical Bracket - before tests

PHOTO 3: Load 1



PHOTO 6: Load 2 - Bracket under load



PHOTO 7: Unloaded - after tests



PHOTO 8: Unloaded - after tests



PHOTO 9: Unloaded Bracket - after tests

Note: Bracket photos are typical of all locations



Horizontal Load Test Ceramic Tile Roof

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	CLIENT		CLIENT PR	OJECT REF. NO.		CLIENT	ORDER NO.	
]	Diversi-Tech Cor	poration	Bracket Test	- Horizontal Load		per	S.A.	
MATERIA	AL SUBMITTED BY	PNL PROJECT NO.	S.O. NO.	PNL LAB NO.	TE	ST DATE	REPORT DATE	
	Client	26-231261	001	ML845913	10/0)4/2023	10/13/2023	
			DESCRIPTION				TECHNICIANS	
Tile r	Tile roof w/ Universal L Foot Bracket & IR-T1 No Penetration Tile Roof Bracket TR, MC, DG							
		TES		E/DESCRIPTION				
damage o using a c brackets.	or permanent deformatior hain hoist and a digital d	n prior to testing. The ho ynamometer. The load d the specimen was ex	prizontal load was app was applied at the c amined for any dama	simulation roof. The test spoled after initial inspection enter of the crossbeam. T ages or deformation while u deformation or damage.	was comp he crossb	leted. The hor	izontal load was applied ched to the solar panel	
		TEST D	OATA & EQUIPM	ENT INFORMATION				
	TEMPERATURE:	88 °F ±	: 3 °F	HL	MIDITY:		15% ± 5%	
	TEST SPECIMEN SIZE:	Tile roof: 39.375	n. x 78.500 in. TEST SPECIMEN ARI		N AREA:	AREA: 21.465 ft ²		
	LOAD TYPE:	PE: Tensile/Pull, applied with chain hoist		TES	T LOAD:	T LOAD: >500 lbf		
	EQUIPMENT TYPE:	Weightronic D	ynamometer	EQUIPMENT	MODEL:	OCS-	Y / 3000 kg Max.	
BRA	ACKET COMPONENT 1:	Universal L F	Foot Bracket BRACKET PART N		T NO. 1:	IF	R-DMLF2000	
BRA	ACKET COMPONENT 2:	IR-T1 No Penetration	Tile Roof Bracket	BRACKET PAR	T NO. 2:	IF	R-FCTR1500	
		V	ISUAL TEST OB	SERVATIONS				
	INITI	AL	UNDER TES	ST LOAD (500 lbf)		AFTER LOA	D REMOVAL	
NO.	BRACKET DEFORMATION	PANEL DEFORMATION	BRACKET DEFORMATION	PANEL DEFORMATION		ACKET RMATION	PANEL DEFORMATION	
1	None	None	Moderate	Moderate	1	None	None	
2	None	None	Moderate	Moderate	I	None	None	
3	None	None	Moderate	Moderate	None		None	
4	4 None None Moderate Moderate None None							
			OBSERVA	TIONS				
	After remov		Ũ	nal position with no permar f permanent damage or de				

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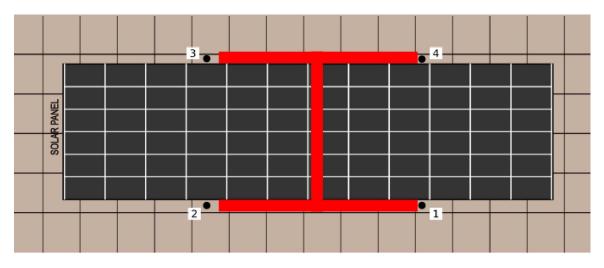
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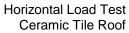
Horizontal Load Test Ceramic Tile Roof

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CLIENT		CLIENT PRO	OJECT REF. NO.	CLIENT ORDER NO.	
Diversi-Tech Corporation		Bracket Test	- Horizontal Load	ре	er S.A.
MATERIAL SUBMITTED BY	PNL PROJECT NO.	S.O. NO.	PNL LAB NO.	TEST DATE	REPORT DATE
Client	26-231261	001	ML845913	10/04/2023	10/13/2023
	TECHNICIANS				
Tile roof w/ Universa	TR, MC, DG				





Bracket/Panel Gap Spacing Check





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CLIENT	-	CLIENT PRO	OJECT REF. NO.	CLIENT	ORDER NO.
Diversi-Tech Corporation		Bracket Test ·	- Horizontal Load	ре	er S.A.
MATERIAL SUBMITTED BY	PNL PROJECT NO.	S.O. NO.	PNL LAB NO.	TEST DATE	REPORT DATE
Client	26-231261	001	ML845913	10/04/2023	10/13/2023
	TECHNICIANS				
Tile roof w/ Universa	TR, MC, DG				

PHOTOS



PHOTO 1: Overview of solar panel and tile roof deck - before tests

PHOTO 2: Bracket with no load

PHOTO 3: Test setup for horizontal pull load



PHOTO 4: Applied load



PHOTO 5: Bracket under load



PHOTO 6: Test setup after test



Uplift Tensile Load Test Ceramic Tile Roof

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	CLIENT		CLIENT PR	OJECT REF. NO.	C	LIENT ORDER NO.	
[Diversi-Tech Cor	poration	Bracket Te	Bracket Test - Uplift Load		per S.A.	
MATERIA	AL SUBMITTED BY	PNL PROJECT NO.	S.O. NO.	PNL LAB NO.	TEST DAT	E REPORT DATE	
	Client	26-231261	001	ML845913	10/04/20	10/13/2023	
		SAMPLE	DESCRIPTION			TECHNICIANS	
Tile ro	oof w/ Universal	L Foot Bracket	& IR-T1 No P	enetration Tile Ro	of Bracket	TR, MC, DG	
		TE		E/DESCRIPTION			
or perma chain hoi brackets.	nent deformation prior to ist and a digital dynamor	testing. The uplift tens neter. The load was ap ed the specimen was ex	ile pull load was app pplied at the center p xamined for any dam	lied after initial inspection of the cross beam. The cross beam.	was completed. L le cross beam wa	ally examined for any damage Jplift load was applied using a as attached to the solar panel vertical load was released and	
		TEST D	OATA & EQUIPM	ENT INFORMATION			
	TEMPERATURE:	88 °F ±	= 3 °F	HL	JMIDITY:	15% ± 5%	
	TEST SPECIMEN SIZE:	Tile roof: 39.375	in. x 78.500 in.	TEST SPECIME	N AREA:	21.465 ft ²	
	LOAD TYPE:	Uplift tensile, applie	ed with chain hoist	TES	T LOAD:	710 lbf	
	EQUIPMENT TYPE:	Weightronic D	ynamometer	EQUIPMENT	MODEL:	OCS-Y / 3000 kg Max.	
BRA	ACKET COMPONENT 1:	Universal L F	oot Bracket	BRACKET PAR	T NO. 1:	IR-DMLF2000	
BRA	ACKET COMPONENT 2:	IR-T1 No Penetration	Tile Roof Bracket	BRACKET PAR	T NO. 2:	IR-FCTR1500	
		V	ISUAL TEST OF	SERVATIONS			
	INIT	AL	UNDER UPLIFT	TEST LOAD (710 lbf)	AFTE	R LOAD REMOVAL	
NO.	BRACKET DEFORMATION	PANEL DEFORMATION	BRACKET DEFORMATION	PANEL DEFORMATION	BRACKET DEFORMATI		
1	None	None	Moderate	Moderate	None	None	
2	None	None	Moderate	Moderate	None	None	
3	None	None	Moderate	Severe	None	None	
4	4 None None Moderate None None None						
	OBSERVATIONS						
	After removal of the uplift test load all brackets returned to original position with no permanent deformation noted.						
	The solar panel did not show any signs of permanent damage or deformation.						
	At Bracket No. 3, the tile roof shingle separated at the glue bond from the shingle underneath.						

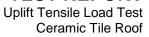
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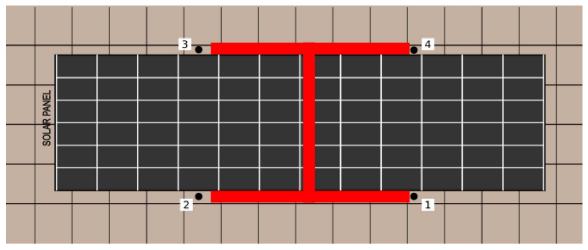
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CLIENT		CLIENT PROJ	ECT REF. NO.	CLIENT	ORDER NO.
Diversi-Tech Corporation		Bracket Test - Uplift Load		per S.A.	
MATERIAL SUBMITTED BY	PNL PROJECT NO.	S.O. NO.	PNL LAB NO.	TEST DATE	REPORT DATE
Client	26-231261	001	ML845913	10/04/2023	10/13/2023
	TECHNICIANS				
Tile roof w/ Universa	TR, MC, DG				





Bracket/Panel Gap Spacing Check



Uplift Tensile Load Test Ceramic Tile Roof

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CLIENT		CLIENT PROJECT REF. NO.		CLIENT ORDER NO.	
Diversi-Tech Corporation		Bracket Test - Uplift Load		per S.A.	
MATERIAL SUBMITTED BY	PNL PROJECT NO.	S.O. NO.	PNL LAB NO.	TEST DATE	REPORT DATE
Client	26-231261	001	ML845913	10/04/2023	10/13/2023
SAMPLE DESCRIPTION					TECHNICIANS
Tile roof w/ Universal L Foot Bracket & IR-T1 No Penetration Tile Roof Bracket					TR, MC, DG



PHOTO 1: Overview of solar panel and tile roof deck - before tests

PHOTOS



PHOTO 2: Overview of tensile test setup and connection



PHOTO 3: Brackets with no load



PHOTO 4: Test setup



PHOTO 5: Test specimen while under tensile load



PHOTO 6: Dynamometer scale under load



PHOTO 7: Bracket under test load



PHOTO 8: Bracket unloaded after test



PHOTO 9: Bracket unloaded after test - roof tile bond pulled apart.