Daikin AC Summary of Entire Proposal for Altherma Air To Water Heat Pump CA Title 24 ECM

Challenge: -

Daikin Altherma is an Air to Water Heat Pump System designed for Space Heating, Space Cooling and supplying hot water for an integrated DHW indirect tank.

The existing test procedures in the U.S. do not adequately define testing parameters for Air to Water systems and thus the U.S. DOE awarded Daikin Altherma a Waiver (No.s CAC-024, CAC-028) from those test procedures and instead instructed that Daikin use the EU test procedure (EN14511) as an alternate rating method.

The EN14511 testing and rating standard provides metrics to determine the system full load EER and COP. However to meet Title 24 requirements in CA, it is necessary to submit performance values for SEER, HSPF as well as E.F. for the DHW portion of the system (if utilized).

Proposal: -

To overcome this need Daikin propose to use the following metrics to establish the effective performance values of the Daikin Altherma System: -

Metric	Note	Proposal
COP	Heating Efficiency (Full Load)	Use DOE Certified Values per U.S. DOE Waiver
EER	Cooling Efficiency (Full Load)	Use DOE Certified Values per U.S. DOE Waiver
HSPF	Heating Efficiency (Seasonal)	Use CEC COP > HSPF Calculation Method (HSPF = 3.2*COP-2.4)
SEER	Cooling Efficiency (Seasonal)	Use EER at 95F & 82F and utilize std SEER calculation
Alternative E.F.	Energy Factor (DHW)	Use COP at Nominal Condition with leaving water temp of 122F / 131F and base DHW usage on 56.5Gallons per day as worse case CA condition

Results: -

Description	Heat Source Model No.	Cooling Mode		Heating Mode		DHW
		EER (95F)	SEER	COP	HSPF	E.F
Split Altherma LT	ERLQ036BAVJU	12.17	17.50	4.34	11.49	2.42
Split Altherma LT	ERLQ048BAVJU	9.95	16.53	4.24	11.17	2.53
Split Altherma LT	ERLQ054BAVJU	8.73	13.00	4.03	10.50	2.42
MonoBloc Altherma LT	EBLQ036BA6VJU	11.21	16.63	4.32	11.42	2.38
MonoBloc Altherma LT	EBLQ048BA6VJU	9.42	16.09	4.2	11.04	2.50
MonoBloc Altherma LT	EBLQ054BA6VJU	8.89	13.00	4.07	10.62	2.41
MonoBloc Altherma LT	EDLQ036BA6VJU			4.32	11.42	2.38
MonoBloc Altherma LT	EDLQ048BA6VJU			4.2	11.04	2.50
MonoBloc Altherma LT	EDLQ054BA6VJU			4.07	10.62	2.41

Daikin AC Proposal for Altherma Air To Water Heat Pump - HSPF Calculation

Challenge: -

Daikin Altherma is an Air to Water Heat Pump System designed for Space Heating, Space Cooling and supplying hot water for an integrated DHW indirect tank.

In space heating applications, the DOE approved test procedures (EN14511) does not determine a HSPF rating, but instead a COP.

To meet Title 24 requirements in CA, it is necessary to submit performance values for HSPF for the Heating solution.

Proposal: -

To overcome this need Daikin propose to use the following metrics to establish the effective performance values of the Daikin Altherma System: -

Use the existing COP to HSPF conversion calculation as follows: ·

$HSPF_{Altherma}$	=	3.2	x	COP	-	2.4

COP = DOE Approved COP value based on EN14511 testing and rating procedure as approved alternative rating method
COP is based on Ambient Temp 44.6F DB / 42.8F WB, and a Leaving Water Temperature condition of 95F.

Daikin AC Summary of Entire Proposal for Altherma Air To Water Heat Pump CA Title 24 ECM

Challenge: -

Daikin Altherma is an Air to Water Heat Pump System designed for Space Heating, Space Cooling and supplying hot water for an integrated DHW indirect tank.

In space cooling applications, the DOE approved test procedures (EN14511) does not determine a SEER rating, but instead a EER.

To meet Title 24 requirements in CA, it is necessary to submit performance values for SEER for the Cooling solution.

Proposal: -

To overcome this need Daikin propose to use the following metrics to establish the effective performance values of the Daikin Altherma System: -

Based on the DOE approved test condition for SEER, Variable systems are tested at a variety of conditions to adddress the seasonal efficiency of the system.

Using the same logic and the performance tables of the Altherma system, it is proposed to calculate an equivalent SEER around the same conditions as follows: -

Std Test Conditions per AHRI Std 210/240 (DOE 10 CFR 430 Part B)

Table 9. Cooling Mode Test Conditions for Units Having a Variable-Speed Compressor

Test Description	Air Entering Indoor Unit Temperature				Air Entering Outdoor Unit Temperature				Compressor Speed	Cooling Air Volume Rate
	Dry-Bulb °F	Dry-Bulb °C	Wet-Bulb °F	Wet-Bulb °C	Dry-Bulb °F	Dry-Bulb °C	Wet-Bulb °F	Wet-Bulb °C		
A_2 Test - required (steady, wet coil)	80.0	26.7	67.0	19.4	95.0	35.0	75.0[1]	23.9[1]	Maximum	Cooling Full-load [2]
B_2 Test - required (steady, wet coil)	80.0	26.7	67.0	19.4	82.0	27.8	65.0[1]	18.3[1]	Maximum	Cooling Full-load [2]
E_V Test - required (steady, wet coil)	80.0	26.7	67.0	19.4	87.0	30.6	69.0[1]	20.6[1]	Intermediate	Cooling Intermediate[3]
B_1 Test - required (steady, wet coil)	80.0	26.7	67.0	19.4	82.0	27.8	65.0[1]	18.3[1]	Minimum	Cooling Minimum[4]
F_1 Test - required (steady, wet coil)	80.0	26.7	67.0	19.4	67.0	19.4	53.5[1]	11.9[1]	Minimum	Cooling Minimum[4]
G_1 Test[5] - optional (steady, dry coil)	80.0	26.7	[6]		67.0	19.4	–		Minimum	Cooling Minimum[4]
I_1 Test[5] - optional (cyclic, dry coil)	80.0	26.7	[6]		67.0	19.4	–		Minimum	[6]

Altherma Test Conditions per EN14511 & Performance Tables

Description	LWT	Ambient	Compressor	
A2 Alternate	64.4F	95F	MAX	100%
B2 Alternate	64.4F	86F	MAX	100%
EV Alternate	64.4F	86F	INT	50%
B1 Alternate	64.4F	86F	MIN	25%
F1 Alternate	64.4F	68F	MIN	25%

Logic:

LWT set at 64.4F as equivalent EN14511 rating point versus 80/67F Air Side Rating Point.

Ambient of 95F, 86F, 68F to be equal or close match to U.S. test procedure and based on available engineering data.

Compressor Speed/Percentage to reflect Engineering Data available (minimum comp is 23% versus 25% used).

Altherma System Performance Data: -

The following information is extracted from Daikin Engineering data documents

Description	Heat Source Model No.	A2 Alternate		B2 Alternate		EV Alternate		B1 Alternate		F1 Alternate	
		kBtu/hr	kW	kBtu/hr	kW	kBtu/hr	kW	kBtu/hr	kW	kBtu/hr	kW
Split Altherma LT	ERLQ036BAVJU	47.6	3.91	50.2	3.48	21.7	1.1	30.71	1.61	33.82	1.25
Split Altherma LT	ERLQ048BAVJU	59.1	5.94	62.6	5.38	27.4	1.48	31.02	1.65	34.02	1.33
Split Altherma LT	ERLQ054BAVJU	60.6	6.94	64.6	6.3	28.5	1.77	39.48	2.94	43.84	2.39
MonoBloc Altherma LT	EBLQ036BA6VJU	43.83	3.91	47.33	3.55	21.7	1.1	30.71	1.61	33.82	1.25
MonoBloc Altherma LT	EBLQ048BA6VJU	54.57	5.79	59.01	5.29	27.4	1.48	31.02	1.65	34.02	1.33
MonoBloc Altherma LT	EBLQ054BA6VJU	57.07	6.43	61.83	5.91	28.5	1.77	39.48	2.94	43.84	2.39
MonoBloc Altherma LT	EDLQ036BA6VJU										
MonoBloc Altherma LT	EDLQ048BA6VJU										
MonoBloc Altherma LT	EDLQ054BA6VJU										

Altherma Results

Description	Heat Source Model No.	A2	B2	EV	B1	F1	SEER
		EER	EER	EER	EER	EER	Result
Split Altherma LT	ERLQ036BAVJU	12.17	14.43	19.70	19.07	27.06	17.50
Split Altherma LT	ERLQ048BAVJU	9.95	11.64	18.54	18.80	25.58	16.53
Split Altherma LT	ERLQ054BAVJU	8.73	10.25	16.12	13.43	18.34	13.00
MonoBloc Altherma LT	EBLQ036BA6VJU	11.21	13.33	19.70	19.07	27.06	16.63
MonoBloc Altherma LT	EBLQ048BA6VJU	9.42	11.16	18.54	18.80	25.58	16.09
MonoBloc Altherma LT	EBLQ054BA6VJU	8.88	10.46	16.12	13.43	18.34	13.00
MonoBloc Altherma LT	EDLQ036BA6VJU						
MonoBloc Altherma LT	EDLQ048BA6VJU						
MonoBloc Altherma LT	EDLQ054BA6VJU						

Daikin AC Proposal for Altherma Air To Water Heat Pump - DHW Calculation

Challenge: -

Daikin Altherma is an Air to Water Heat Pump System designed for Space Heating, Space Cooling and supplying hot water for an integrated DHW indirect tank.

Daikin Altherma can be installed to provide combined Space Heating and DHW production via an Indirect Storage Tank. Typically, the Air Source Heat Pump will provide more than 95% of the heat to support the daily DHW requirements.

The existing E.F. test procedures do not define procedures for testing externally located HPWH type solutions of which an Air to Water HP like Daikin Altherma is classified.

Proposal: -

To overcome this need Daikin propose to use the following metrics to establish the effective performance values for Hot Water Creation from the Daikin Altherma System: -

As the Altherma system is the primary heat source for the creation of hot water, it is proposed to utilize the performance of the Altherma at rated conditions with a leaving water set-point of 122F/131F.

DHW Consumption is based on the state of CA maximum of 56.5Gallons/day - thus an Altherma Tank recovery 1 time per day when the largest tank (80G capacity) is utilized.

Altherma System Performance Data: -

The following information is extracted from Daikin Engineering data documents

Conditions: - Ambient Temperature = 44.6F DB / 42.8F WB, Leaving Water Conditions = 131F

Description	Heat Source Model No.	Heat Capacity kBtu/hr	Power Input kBtu/hr	COP kBtuhr / kBtuhr
Split Altherma LT	ERLQ036BAVJU	32.5	13.44	2.42
Split Altherma LT	ERLQ048BAVJU	41.9	16.59	2.53
Split Altherma LT	ERLQ054BAVJU	45.7	18.85	2.42
MonoBloc Altherma LT	EBLQ036BA6VJU	33.7	14.13	2.38
MonoBloc Altherma LT	EBLQ048BA6VJU	41.9	16.78	2.50
MonoBloc Altherma LT	EBLQ054BA6VJU	47.3	19.59	2.41
MonoBloc Altherma LT	EDLQ036BA6VJU	33.7	14.13	2.38
MonoBloc Altherma LT	EDLQ048BA6VJU	41.9	16.78	2.50
MonoBloc Altherma LT	EDLQ054BA6VJU	47.3	19.59	2.41

Rationale for proposal versus standard Heat Pump Water Heaters

Summary of DOE HPWH test condition to how Daikin Altherma is tested and rated: -

	Scope	DOE Test Procedure	Altherma
Test Conditions	Installation	Tests shall be performed with the water heater installed in accordance with section 4.	Heat Source installed outdoors
	Ambient Temp	For HPWH, dry bulb shall be maintained at 67.5F (+/-1F) @ RH% 49-51.	Performance rated at 44.6F DB
	Supply Water Temp	Shall be maintained at 58F (+/-2F) throughout the test	Supply water is based on 50F
	Storage Tank Temp	The average temp of the water in the tank shall be set to 135F +/-5F	Tank Temperature of 131F
	Supply Water Pressure	Maintain between 40 psig and the maximum allowable pressure specified by the manufacturer	This is consistent
	Electrical	Maintain supply voltage to within +/-1% of the center of the voltage range specified	This is consistent
	Flow Control	Valve shall be installed to provide flow as stated in 5.1.4.1	This is built into the system

Based on the more challenging Ambient, lower supply water temp and compliant Hot Water temperature, Altherma proposal is equivalent

SEER Calcualtions for Variable-Speed Comp.

Enter Values in Yellow Cells

Model

MAX	
INT	
MIN	

0.0

		Capacity (Btu/h)	P-Input (W)	EER (Btu/h･W)
A2	95MAX	43.83	3.9	11.21
B2	86MAX	47.33	3.6	13.33
EV	86INT	21.70	1.1	19.73
B1	86MIN	30.71	1.6	19.07
F1	68MIN	33.82	1.3	27.06

T1	80	F
Tv	87	F
T2	95	F

Cd	0.25

SEER 16.63

<INT能力/INT入力算出係数>

NQ	MQ	NE	ME
-0.4888	-0.1771	-0.3217	0.0228

外気温度 区分	(F)	建物負荷 (Btu/h)	MAX能力 (Btu/h)	MAX入力 (W)	INT能力 (Btu/h)	INT入力 (W)	MIN能力 (Btu/h)	MIN入力 (W)	圧縮機スピード	冷房能力 (Btu/h)	入力 (W)	EER
1	67	3	51	3	25	1	34	1	MIN	34	1	ー
2	72	9	50	3	24	1	33	1	MIN	33	1	ー
3	77	16	49	3	23	1	32	1	MIN	32	1	ー
4	82	23	47	4	23	1	31	2	MIN	31	2	ー
5	87	29	46	4	22	1	30	2	MIN	30	2	ー
6	92	36	45	4	21	1	29	2	INT	36	2	15.44
7	97	43	43	4	20	1	28	2	INT	43	6	7.70
8	102	49	42	4	19	1	27	2	MAX	42	4	ー

Load factor X_MIN	PLF
0.07854	0.76964
0.28360	0.82090
0.50204	0.87551
0.73524	0.93381
0.98472	0.99618
1.00000	1.00000
1.00000	1.00000
1.00000	1.00000

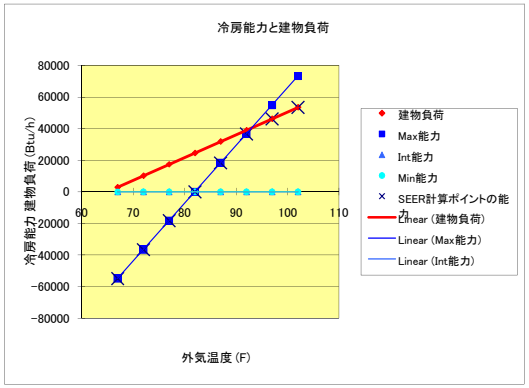
冷房能力 (Btu/h)	入力 (W)	出現時間
0.568	0.027	0.214
2.148	0.109	0.231
3.443	0.185	0.216
3.635	0.204	0.161
3.039	0.178	0.104
1.865	0.121	0.052
0.765	0.099	0.018
0.168	0.016	0.004

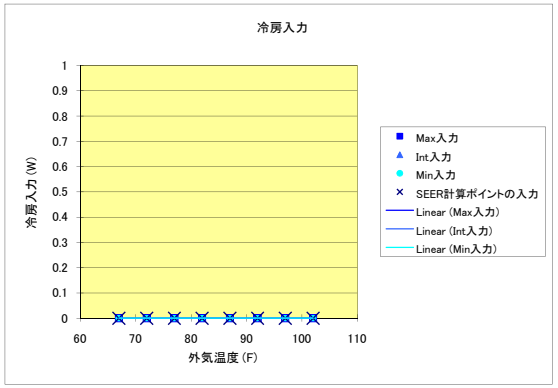
15.630	0.940	1.000	←合計

建物負荷=冷房能力（MIN,INT,MAX）になる温度におけるEER算出

MIN	80						31	2	T1	80	EER_MIN(T1	19.93
INT	87				22	1			Tv	87	EER_INT(Tv)	19.73
MAX	95		44	4					T2	95	EER_MAX(T2	11.21

D	2.245509
B	11.508853
C	-0.0690854
A	-458.63535





<建物負荷=冷房MAX能力になる温度の算出>

温度	建物負荷	MAX能力
97.407939	43	43
97.3306	43	43
97.3307	43	43
97.3308	43	43
97.3309	43	43
97.331	43	43

0

<建物負荷=冷房INT能力になる温度の算出>

温度	建物負荷	ＩＮＴ能力
87.165716	29	22
88.0942	31	22
88.0943	31	22
88.0944	31	22
88.0945	31	22
88.0946	31	22

8

<建物負荷=冷房MIN能力になる温度の算出>

温度	建物負荷	MIN能力
80.748049	21	31
82.8726	24	31
82.8727	24	31
82.8728	24	31
82.8729	24	31
82.873	24	31

-10

計算手順

1 試験結果を入力する。
2 Cd値を入力する。(Cテスト・Dテストを省略する場合は0.25)
3 建物負荷=冷房能力になる温度を算出する。
4 3で求めた温度を入力する。