DAILY HIGH TEMPERATURE WATER PLANT OPERATING LOG

1. COMMAND: | 2. BASE AND LOCATION: | 3. BUILDING: | 4. DATE:

TIME OF DAY	5. FUEL								6. WATER CIRCULATED				7. HTW GENERATOR TEMPERATURES									8. EFFICIENCY ANALYSIS DATA												9. SYSTEM PUMP				10. RECOVERY	
	1		2		3		4		1	2	3	4		1		2		3		4		1			2			3			4			1	2	3	4		
	TYPE	AMOUNT USED	TYPE	AMOUNT USED	TYPE	AMOUNT USED	TYPE	AMOUNT USED	OUTPUT *(gal)*	OUTPUT *(gal)*	OUTPUT *(gal)*	OUTPUT *(gal)*	SUPPLY TEMP *(°F)*	RETURN TEMP *(°F)*	ΔT *(°F)*	RETURN TEMP (°F)	ΔT *(°F)*	RETURN TEMP (°F)	ΔT *(°F)*	RETURN TEMP (°F)	ΔT *(°F)*	O_2 % *(0.xxx)*	STACK TEMP *(°F)*	COMB. AIR TEMP *(°F)*	O_2 % *(0.xxx)*	STACK TEMP *(°F)*	COMB. AIR TEMP *(°F)*	O_2 % *(0.xxx)*	STACK TEMP *(°F)*	COMB. AIR TEMP *(°F)*	O_2 % *(0.xxx)*	STACK TEMP *(°F)*	COMB. AIR TEMP *(°F)*	DISCH PRESS *(psig)*	DISCH PRESS *(psig)*	DISCH PRESS *(psig)*	DISCH PRESS *(psig)*	EXPAN. TANK PRESS *(psig)*	MAKE-UP *(gal)*
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TOTAL									0	0	0	0																										0
AVG																																						
MIN																																						
MAX																																						

11. PLANT INPUT

FUEL USED	TOTAL		HIGHER HEATING VALUE (HHV)	FUEL INPUT
GAS *(Mcf)* :		*Btu/ft³*		
OIL *(gal)* :		*Btu/gal*		
COAL *(lbm)* :		*Btu/lbm*		
TOTAL INPUT *(MMBtu)*				

12. PLANT OUTPUT	1	2	3	4	PLANT
DAILY WATER CIRC. *(gal)*					
HEAT CONTENT *(Btu/lbm)*					
TOTAL OUTPUT *(MMBtu)*					

13. PLANT OVERALL EFFICIENCY, η_{Plant}, *(0.XXX)*

14. % MAKE-UP

15. COMBUSTION EFFICIENCY, η_C, *(0.xxx)*

1	2	3	4	PLANT

SIGNATURE *(Boiler Operations Supervisor):*

DATE REVIEWED:

16. OPERATOR NAMES

First Shift:

Second Shift:

Third Shift:

17. BLOWDOWN (gal)

TOTAL 0

REMARKS:

PURPOSE: Use with Air Force high temperature water (HTW) plants with operating pressures greater than 160 psig IAW AFI 32-1068.

DIRECTIONS: This form is intended for recording daily operating data on individual HTW generators and used to provide the information for the AF Form 1165, Monthly High Temperature Water Plant Operating Log. Each time an operator visits a heating plant that is not constantly attended, IAW AFI 32-1068, the operator will enter the information obtainable from the existing permanently installed instrumentation on this form for the specific HTW generator. Constantly attended HTW plants will record the data for Items 5-10 hourly. The daily amounts in items 5-10 should be totaled and averaged, as appropriate, and Items 11 -15 calculated. The completed form will be reviewed by a supervisor of boiler operations, who will ensure proper posting of information from this form on an AF Form 1165, Monthly High Temperature Water Plant Operating Log and the calculation of the combustion and overall efficiencies. This form will be signed and dated when review is complete. Where there is more than one plant, a separate log is required. Use additional sheets when more than four HTW generators are in operation during the day.

Items 1-4. Self-explanatory.

Item 5. Fuel Used. Enter the type of fuel, Gas (G), Oil (O), or Coal (C). When operating two different gases, e.g. natural gas and propane, annotate how long each is used in the Remarks section. Enter the quantity of fuel used for each boiler. Gas is measured in thousands of cubic feet (Mcf) as read from the gas meter. Oil is measured in gallons (gal) of oil from fuel metering or tank gaging. Coal is measured in pound-mass (lbm) of coal burned from actual weighing or estimated use. When operating two different gases, e.g. natural gas and propane, annotate how long each is used in the Remarks section. Enter the quantity of fuel used for each HTW generator.

Item 6. Water Circulated. Enter the flow output from each HTW generator, in gallons, since the last entry.

Item 7. HTW Generator Temperature. Record the HTW supply temperature entering the distribution system and the temperature of return water entering each HTW generator in °F. Calculate and record the temperature difference, ΔT, between the supply and return temperatures.

Item 8. Data for Calculating Efficiencies. Record the Oxygen (O_2) percentage, recorded as 0.XXX, of the flue gas and the stack temperature, in °F, from each HTW generator. These measurements will be taken after economizers or air preheater for each boiler. *(The O_2 and stack temperatures readings must be properly taken to ensure accurate readings. Check instruments frequently.)* Record the temperature of the combustion air entering the HTW generator in °F.

Item 9. System Pump. Record the pump discharge pressure, in psig, from each HTW generator.

Item 10. Recovery. Record the expansion tank pressure in psig and tank temperature in °F. Record the metered gallons of make-up water.

Item 11. Plant Input. Sum and enter the total daily amount of each type of fuel used from each HTW generator, including amounts from additional sheets, as recorded in Item 5. Enter the HHV for each fuel type from vendor supplied or sampling records. Calculate heat input for each fuel by multiplying the appropriate total by the corresponding HHV and dividing by 1,000,000 to get Million Btu (MMBtu) values. Gas volume values must be multiplied by 1000 to convert from thousands of cubic feet (Mcf). Sum the Fuel Inputs to create the Total Input value in MMBtu.

Item 12. Plant Output. Enter the amount of water circulated for each HTW generator from Item 6 and calculate the Plant Daily Water Circulated amount by summing the Daily Water Circulated from each HTW generator, to include any additional sheets. Determine the Heat Content for each HTW generator using the average ΔT for the day, found in Item 7, and multiplying the appropriate Specific Heat & Volume/Mass Factor shown below based on the daily average Supply Temperature in Item 7. Multiply Daily Water Circulated Amount by the heat content amount and divide by 1,000,000 to get the Total Output in Million Btu (MMBtu) for each HTW generator. Calculate the Plant Total Output by summing the Total Output from each HTW generator, to included any additional sheets.

SUPPLY TEMP (°F)	SPECIFIC HEAT (cp) (Btu/lbm-°F) & VOL/MASS (gal/lbm) FACTOR
300	7.93
350	7.77
400	7.78
450	7.84
500	7.85

Item 13. Plant Overall Efficiency - η_{Plant}. Divide Item 12, Total Output, by Item 11, Total Input. Record to three decimal places. (0.xxx).

Item 14. Make-Up Water Percentage. Calculate and enter the total daily make-up water percentage by dividing the Total Make-Up (gal) in Item 10,, including any additional sheets, by the Plant Daily Water Circulated (gal) listed in Item 12. Record as 0.xxx.

Item 15. Combustion Efficiency. η_c. Using readings from a combustion analyzer, applicable efficiency charts found in AFI 32-1068 corrected for altitude, or applicable efficiency charts provided in the manufacturer's O & M documentation, determine the combustion efficiency for each HTW generator ($\eta_{c\text{-}1}$, $\eta_{c\text{-}2}$, ...$\eta_{c\text{-}n}$) based on the specific fuel burned. Use the average values in Item 8 for the O_2 percentage and the Net Stack Temperature (STACK Δ TEMP - stack temperature minus combustion air temperature). Calculate the Plant Combustion Efficiency, $\eta_{c\text{-}Plant}$, using a weighed average of the efficiencies from each HTW generator as a fraction of the water circulated by that generator to the Plant Daily Water Circulated, including amounts from additional sheets. See formula below. Record to three decimal places (0.XXX).

$$\eta_{c\text{-}Plant} = \Sigma \text{ (Total Output}_n \text{/Plant Daily Water Circulated) } \eta_{c\text{-}n}$$

Where n = HTW generator number

Item 16. Operator Name. List the names of personnel working on the shift

Item 17. Blowdown. Each shift perform and record the gallons of blowdown. At the end of the day the amount will be totaled.

UNIT NOMENCLATURE:

gal - gallon
GJ – gigaJoule
kg – kilogram
kJ/kg – kilojoule/ kilogram)
kPa – kiloPascal
L – liter
lbm - pound - mass
Mcf – Thousands of cubic feet (can be incorrectly listed as kcf)
Mlbm – thousands of pound - mass
MMBtu – Million (Thousand Thousand) British thermal unit
psig – Pounds per square inch gauge
1000 m^3 – thousand cubic meters

METRIC CONVERSION

MULTIPLY	BY	TO OBTAIN
kPa	0.1450	psig
kg	2.2046	lbm
1000 m^3	35.310	Mcf
L	0.2642	gal
kJ/kg	0.4299	Btu/lbm
GJ	0.9479	MMBtu

TEMPERATURE CONVERSION TO OBTAIN DEGREES FAHRENHEIT

$T_{°F} = 1.8T_{°C} + 32$