



SEQUENCE OF OPERATIONS:

GENERAL OVERVIEW OF RECOVERED THERMAL ENERGY FROM FUEL CELL-
 THE FUEL CELLS HAVE TWO SEPARATE RECOVERABLE THERMAL ENERGY SYSTEMS, HIGH GRADE HOT WATER AND LOW GRADE HOT WATER. THE HIGH GRADE HOT WATER WILL BE CONNECTED TO A NEW ABSORPTION CHILLER AND TO THE SERVICE BUILDING B'S EXISTING HEATING HOT WATER SYSTEM. THE LOW GRADE HOT WATER WILL BE CONNECTED VIA A DOUBLE-WALLED, PLATE AND FRAME HEAT EXCHANGER TO THE DOMESTIC HOT WATER SYSTEM LOCATED IN SERVICE BUILDING B. IF ALL OF THE HIGH GRADE HEAT IS NOT UTILIZED BY THE HEATING HOT WATER AND ABSORPTION CHILLER SYSTEM, THE EXCESS THERMAL ENERGY WILL BE TRANSFERRED (INTERIALLY TO THE FUEL CELLS) TO THE LOW GRADE HOT WATER SYSTEM. IF ALL OF THE THERMAL HEAT IS NOT UTILIZED BY THE FACILITY THE COOLING MODULES WILL DUMP THE EXCESS HEAT TO THE ATMOSPHERE.

HIGH GRADE AND LOW GRADE CIRCULATION PUMPS-
 WHEN THE FUEL CELLS ARE TURNED ON AND THEY BEGIN TO UTILIZE FUEL, THE FUEL CELL WILL SEND A 24 VOLT CONTROL SIGNAL TO THE STAND ALONE CONTROL SYSTEMS FOR THE HIGH GRADE HEATING, LOW GRADE HEATING AND ABSORPTION CHILLER SYSTEM ENABLING THE WATER CIRCULATION PUMPS TO START. WHEN THE FUEL CELLS GO INTO IDLE MODE THE CIRCULATION PUMPS WILL REMAIN OPERATING. THE CIRCULATION PUMPS WILL ONLY SHUT DOWN WHEN THE FUEL CELLS ALL SHUT DOWN.

HIGH GRADE HEAT; ABSORPTION CHILLER AND HEATING HOT WATER SYSTEM-
 WHEN THE FUEL CELL FIRST COMES ON LINE IT DOES NOT PRODUCE RECOVERABLE HEAT. RECOVERABLE THERMAL ENERGY IS NOT AVAILABLE FOR SEVERAL HOURS AFTER THE SYSTEM IS FIRST BROUGHT ON LINE. FOR PROPER OPERATION OF THE ABSORPTION CHILLER THE ENTERING HOT WATER TEMPERATURE MUST BE 203°F. IN ORDER FOR THE FUEL CELLS TO PRODUCE 203°F HIGH GRADE HOT WATER (HGHW), THE RETURN WATER BACK TO THE FUEL CELL MUST BE 185.7°F (BOL) & 180.3°F (EOL). THE MIXING CONTROL VALVE CV-3 AT THE ABSORPTION CHILLER WILL BE CONTROLLED BY THE ABSORPTION CHILLER CONTROL SYSTEM. THE CHILLER WHEN OPERATING AS DESIGNED WILL FLOW 75 GPM WITH A LEAVING HGHW TEMPERATURE OF 179.3°F. THE BUILDING'S HEATING HOT WATER SYSTEM WHICH RETURNS FROM THE BUILDING AT APPROXIMATELY 140°F COULD POTENTIALLY REDUCE THE HGHW RETURN TEMPERATURE TO THE FUEL CELL IF NOT CLOSELY MAINTAINED. MIXING CONTROL VALVE CV-1 AT THE NEW HEATING HOT WATER HEAT EXCHANGER (HX-1) WILL ENSURE THAT THE WATER RETURNING TO THE FUEL CELLS REMAINS AT 185.7°F (BOL) & 180.3°F (EOL).

PUMPS HWP-1 AND HWP-3 ARE ENABLED WHEN THE FUEL CELLS ARE OPERATIONAL. AN ENABLE/DISABLE SIGNAL IS GENERATED BY THE FUEL CELLS AS AN INPUT TO THE CONTROLLER. MIXING VALVE CV-1 IS MODULATED OPEN TO ALLOW FLOW OF THE HGHW TO HX-1 ANYTIME THE SUPPLY WATER TEMPERATURE FROM THE FUEL CELL IS AT OR ABOVE 203°F (TS-9). IF THE SUPPLY HGHW TEMPERATURE DROPS BELOW 203°F, CV-1 MODULATE TO BYPASS HGHW FLOW PAST HX-1. THE CONTROL SIGNAL TO CV-1 IS OVERRIDDEN TO BYPASS HGHW FLOW PAST THE HX-1 TO ENSURE A HGHW RETURN TEMPERATURE IS MAINTAINED AT 188.9°F (BOL) AND 180.8°F (EOL). THIS HGHW RETURN TEMPERATURE SET POINT WILL REQUIRE PERIODIC ADJUSTMENT AS THE FUEL CELL AGES AND ADDITIONAL HEAT IS BEING GENERATED BY THE FUEL CELLS. THE HGHW RETURN TEMPERATURE CONTROL WILL HAVE PRIORITY OVER THE TEMPERATURE CONTROL SET POINT TO ENSURE THAT THE WATER LEAVING THE FUEL CELLS CAN BE MAINTAINED AT 203°F.

LOW GRADE HEAT AND DOMESTIC HOT WATER SYSTEM-
 TO PREVENT THE DOMESTIC HOT WATER SYSTEM FROM BEING OVER HEATED, CONTROL VALVE, CV-2 WILL MODULATE TO BY-PASS SOME OR ALL LGHW AROUND THE NEW DOUBLE WALLED, PLATE AND FRAME HEAT EXCHANGER (HX-2). PUMP HWP-2 IS ENABLED WHEN THE FUEL CELL FC-3 IS OPERATING. AN ENABLE/DISABLE SIGNAL IS GENERATED BY THE FUEL CELL FC-3 AS AN INPUT TO THE CONTROLLER. MIXING VALVE CV-2 IS MODULATED OPEN TO ALLOW LGHW TO FLOW TO HX-2 ANYTIME THE LGHW SUPPLY TEMPERATURE IS ABOVE 140°F (TS-12). CV-2 IS MODULATED TO MAINTAIN A TEMPERATURE OF THE DOMESTIC HOT WATER (DHW) LEAVING HX-2 AT 140°F (TS-13). IF DHW LEAVING HX-2 SHALL BE CONTROLLED TO NOT EXCEED 140°F.

CONDENSER WATER SYSTEM-
 PUMPS CWP-1 AND CWP-3 ARE ENABLED WHEN THE FUEL CELLS ARE IN OPERATION. AN ENABLE/DISABLE SIGNAL IS GENERATED BY THE FUEL CELLS AS AN INPUT TO THE CONTROLLER. THE VARIABLE FREQUENCY DRIVE (VFD) ON THE COOLING TOWER FAN IS ENABLED AFTER CWP-1 IS ENABLED AND IF THE CONDENSER WATER IS ABOVE 80°F (TS-14). THE VFD WILL ADJUST THE FAN SPEED BETWEEN 10% TO 100% TO MAINTAIN THE LEAVING WATER TEMPERATURE OF 80°F (ADJ.). IF THE CW TEMPERATURE DROPS BELOW 10°F (ADJ.) FROM SET POINT THE FAN WILL SHUT DOWN. THE FAN WILL NOT COME BACK ON LINE UNTIL THE CW TEMPERATURE RISES ABOVE 80°F AGAIN.

STAND ALONE TEMPERATURE CONTROLLER SHALL BE HONEYWELL 1775M2006/1 OR EQUIVALENT. TYPICAL FOR LOW GRADE HOT WATER SYSTEM, HEATING HOT WATER SYSTEM AND CONDENSER WATER SYSTEM (THREE TOTAL).

FUEL CELL FLOW DIAGRAM
 NOT TO SCALE



**CBS TELEVISION CITY
 FUEL CELL INSTALLATION PROJECT**

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ID	DATE	REMARKS
1	17/02/02	PRELIMINARY DESIGN REVIEW
2	18/20/02	PLAN CHECK
3	19/04/02	100% FIELD CLARIFICATIONS
4	19/09/02	100% FIELD CLARIFICATIONS
5	19/25/02	100% FIELD CLARIFICATIONS

ENGR:	WTB
CHK'D BY:	WTB
DATE:	9/19/12
JOB NO.:	12-010
SCALE:	AS NOTED

