UNITED TECHNOLOGIES CARRIER

SERVICE BULLETIN

Title: 19DM DIFFUSER WALL CONTROL ALGORITHM

Number: C8708
Date: 7/2/87
Supersedes: NEW
Date:

Models Affected: 19DM AND 19DR WITH 19DM COMPRESSORS

PURPOSE

The purpose of this bulletin is to provide information regarding an improved 19DM diffuser wall control algorithm.

BACKGROUND

The 19DM compressor achieves high efficiency through the use of vanes to control the diffusion of the high velocity flow leaving the impeller. Conventional vaned diffusers will improve full load efficiency but tend to stall and become inefficient at part load. The 19DM vaned diffuser is designed to overcome this problem by means of a movable, slotted diffuser wall which slides over the vanes. At the full load design point, the wall is open 100%. As the load decreases and the flow angle of the refrigerant gas entering the diffuser begins to decrease, the wall starts to close maintaining the proper flow angle into the diffuser. At minimum load, the diffuser wall is open 11%.

Figure 1 illustrates the relationship between compressor head and flow and the optimum diffuser wall position. If the diffuser wall is open too far for a given head and flow, the compressor will surge. If the diffuser wall is not open far enough, the compressor might not have enough capacity. The wall is positioned by the 32MP control based on the difference between condenser and cooler saturation temperature (head) and motor amps (flow).

PROBLEM DEFINITION

The original microprocessor control logic included provision for adjusting the wall position using configuration switches. Experience has shown that finding the proper settings can be a time consuming process and that an improved control algorithm would be of benefit.

DESIGN IMPROVEMENTS

The evaporator temperature sensor has been moved up on the side of the vessel as shown on Figure 2 and is sprayed with liquid refrigerant from the poppet chamber. There is a strainer in the 3/8 inch copper tube to prevent plugging of the orifice. The strainer can be cleaned or replaced by breaking the flare fitting. This sensor measures the cooler saturation temperature consistently within one degree F.

File: Controls/Wiring

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The condenser temperature sensor well has been redesigned as shown on Figure 2 to minimize errors due to heat transfer and liquid subcooling. Since some subcooling actually occurs on the condenser tubes, the sensor reads about 2 degrees F low at full load. This error decreases linearly to 0 degrees F at zero load. The microprocessor is programmed to compensate for this deviation. With the compensation, this sensor also consistently measures saturation temperature within one degree F.

Percent motor amps is used as an indication of compressor flow. As a means of compensating for the variation in percent motor amps due to normal variation in part load power factor, the value used for percent motor amps when determining wall position is adjusted. Three dip switches have been allocated to input one of eight correction factors. All available motor amp correction factor dip switch settings for 17 and 19, DK and DM and 19EB chillers are listed on Table I. Table II indicates the proper motor amp correction factor for each motor used on centrifugal water chillers which have the 32MP control.

Three dip switches have been allocated to input one of eight compressor selection zones which are based on where in the selection area the full load head and flow was selected. In cases where the selection is at the low end of the selection area, the diffuser wall must be partially closed, even at full load, as can been seen on figure 1. The Equipment Selection System software has been revised for both main frame and P C to print out the proper selection zone for 19DM compressors.

A configuration switch setting tag has been added to the control panel to indicate the factory settings for dip switches. Since some dip switches can only be set based on local conditions at the time of chiller start-up, a start-up setting column is provided. It is intended that all settings be marked in this column at the time of start-up for future reference. Figure 3 is a sample tag.

To make sure that the diffuser wall is completely closed during the self calibration routine which occurs on the first start after a loss of control power or POR, the wall is closed for at least 2 minutes and until two wall position readings taken 20 seconds apart show less than 1 % decrease in wall position.

The dip switch settings per Table I for impeller diameter have been adjusted one step down from the original settings.

SOFTWARE CHANGEOUT

Service Bulletin C8707 indicates that Versions VI, VIa and VII are the only currently valid versions of single compressor software. The software changes described above, constitute Version VII. For existing 19DM chillers with Version VI or VIa software, it is not necessary to change the software to Version VII as long as the diffuser wall is functioning satisfactorily.

Since Versions VI and VIa will not be stocked in Service Parts, any replacement of these versions will be with Version VII. Version VII is a direct replacement for Versions VI and VIa. For existing chillers, as long as dip switches 4-3 through 4-8 remain turned off, it is not necessary to make any other changes as a result of changing the software. If it is

decided to reconfigure the dip switches, then all settings must be as described in this bulletin.

If the new software is used with chillers having the original condenser and evaporator temperature sensor arrangement and it is decided to reconfigure the dip switches, the configuration switch settings for impeller diameter should be adjusted one step down (smaller dia code, larger dia mult) from those indicated in this bulletin to compensate for measurement errors.

In some cases, resistors have been added in the field as a means of compensation. When changing to the new software, all such resistors should be removed if it is decided to reconfigure the dip switches.

OVERSIZE MOTORS

On new chillers it is intended that the above design improvements will eliminate the need for field adjustment of factory configuration switch settings on new chillers. An adjustment will be required in the case of an oversize motor.

Oversize motors should not be selected for 19DM applications. If this does occur, the motor factor should be adjusted one step larger for each motor size oversize. For example, if a 460 volt, 60 Hz, CQ motor were to be used for an application where a CN motor would have been large enough, the dip switches should be set for a motor amp correction factor of 7, not 5 as shown on page 12.

COMPRESSOR SELECTION ZONES

Compressor selection zones can be determined by reselecting the chiller on ESS.

SENSOR REPLACEMENT

If the condenser temperature sensor is replaced, care must be taken that the sensor is fully inserted into the well. If this is not done, the sensor will read low. As shown on figure 4, there are two internal steps in the well. It is necessary to measure the depth of the well with a wire and mark the jacket of the sensor lead to insure complete insertion.

If the evaporator temperature sensor is replaced, care must be taken that the sensor is fully inserted into the well. The heat shrink sleeving should touch the compression fitting.

AIR IN CONDENSER

If, with proper configuration switch settings, the compressor surges, the unit should be checked for the presence of air in the condenser. Since refrigerant saturation temperature is used to indicate compressor lift, the indicated lift will be less that the actual lift if air is present. This will cause the diffuser wall to open too far.

ADDITIONAL COMPENSATION

If it is determined that air is not present in the condenser and the compressor is surging, the configuration switches for impeller diameter should be set for progressively smaller diameters until the surge is eliminated.

MOTOR AMP CALIBRATION

If the initial motor amp calibration is too high, the compressor may surge when first started up. To avoid this complication, start with the motor amp calibration set low and then increase the calibration untill the percent amps matches the actual percent amps. Keep in mind that if the amps are set too low the diffuser wall may not open and capacity will be minimal even with guide vanes wide open.

IMPLEMENTATION

This change to software was effective for all single compressor 19 and 17 DK/DM/DR units shipped on or following June 25, 1987. The serial numbers for the first week of production which included the change are as follows (in serial number order):

	JOB NO	SER NO		JOB NO	SER NO		JOB NO	SER NO
DM	7210H502	37935	DK	7010H600	39716	DK	77401700	39764
DK	7500H604	39271	DK	7900N600	39720	DK	7100H501	39781
DK	6900N601	39297	DK	6140H506	39740	DK	7100H501	39782
DK	6900N601	39298	DK		39743	DK	7140H500	39795
DK	7770H601	39424	DK	7310H600	39744	DK	7640H510	39801
DK	7210H502	39497	DK	77110230	39750	DM	7600H602	39811
DR	77403101	39662	DK	77401700	39761	DK	7310H600	39817
DM	7590H500	39702	DK	77401700	39762			
DK	7140H500	39705	DK	77401700	39763			

EXAMPLE

19DM77355CP 460/3/60 290 IKW WYE-DELTA STARTER SELECTION ZONE 2

1-1	ON	19DM
1-2	OFF	NON-19CB
1-3	OFF	1 DEG DEADBAND
1-4	OFF	5 DEG PROP BAND
1-5	OFF	60 HZ POWER
1-6	OFF	REDUCED INRUSH STARTER
1-7	OFF	STANDARD THERMISTER MOTOR SENSOR
1-8	OFF	STANDARD THERMISTER THRUST SENSOR
2-1	OFF	CHILLER NUMBER 0
2-2	OFF	
2-3	OFF	
2-4	OFF	DEGREES F
2-5	OFF	COMPRESSOR CODE 355 HAVING A FULL OPEN DIFFUSER WIDTH OF .720
2-6	OFF	INCHES
2-7	OFF	
2-8	ON	
4-1	OFF	
4-2	OFF	
3-1	OFF	FRESH WATER
3-2	OFF	IMPELLER DIAMETER NO 5
3-3	ON	
3-4	OFF	
3-5	OFF	
3-6	OFF	RAMP LOADING RATE OF 2.25 DEG F PER MINUTE
3-7	OFF	
3-8	OFF	
4-3	ON	COMPRESSOR SELECTION ZONE 2
4-4	OFF	
4-5	OFF	
4-6	OFF	460 VOLT, 60 HZ CP MOTOR HAS AN AMPS CORRECTION FACTOR OF 2 FROM
4-7	OFF	TABLE II. INCREASE FACTOR TO 3 BECAUSE MAX IKW OF ONE SIZE
4-8	OFF	SMALLER MOTOR (CN) IS 292.

FIGURE 1

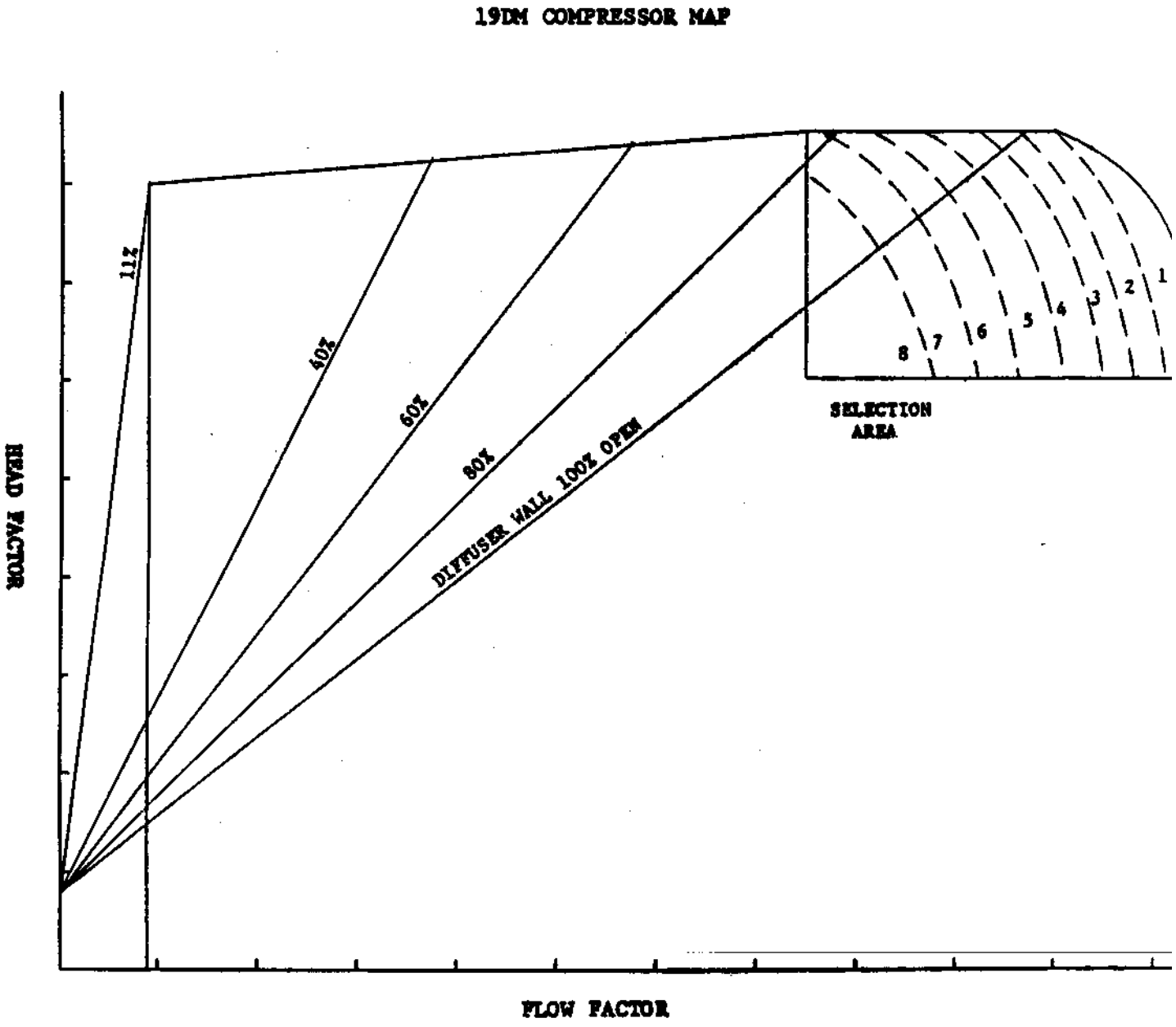
19DM COMPRESSOR MAP
HEAD FACTOR
FLOW FACTOR
11%
40%
60%
80%
DIFFUSER WALL 100% OPEN
SELECTION AREA
1
2
3
4
5
6
7
8

FIGURE 2

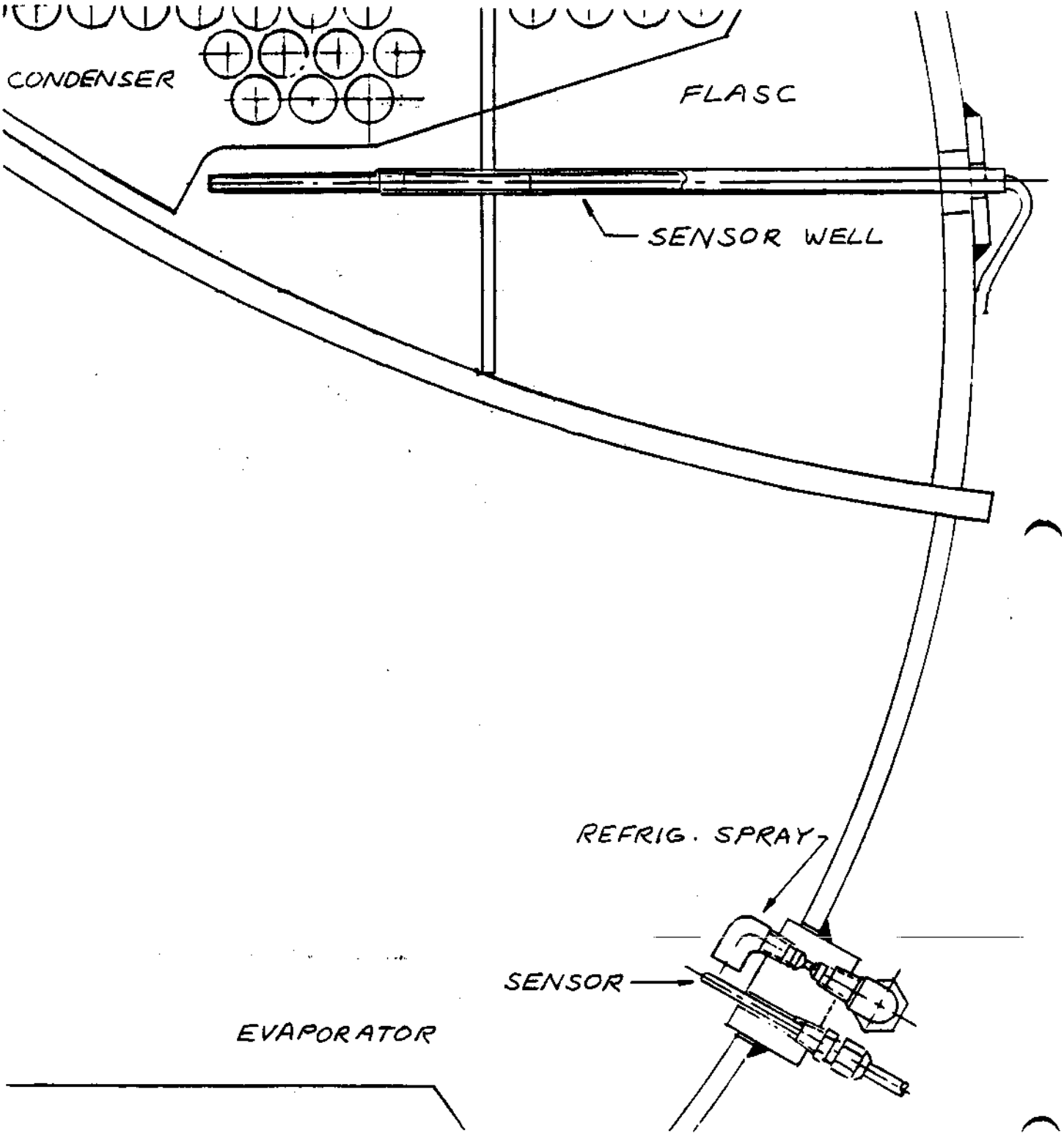
CONDENSER
FLASC
SENSOR WELL
REFRIG. SPRAY
SENSOR
EVAPORATOR

FIGURE 3

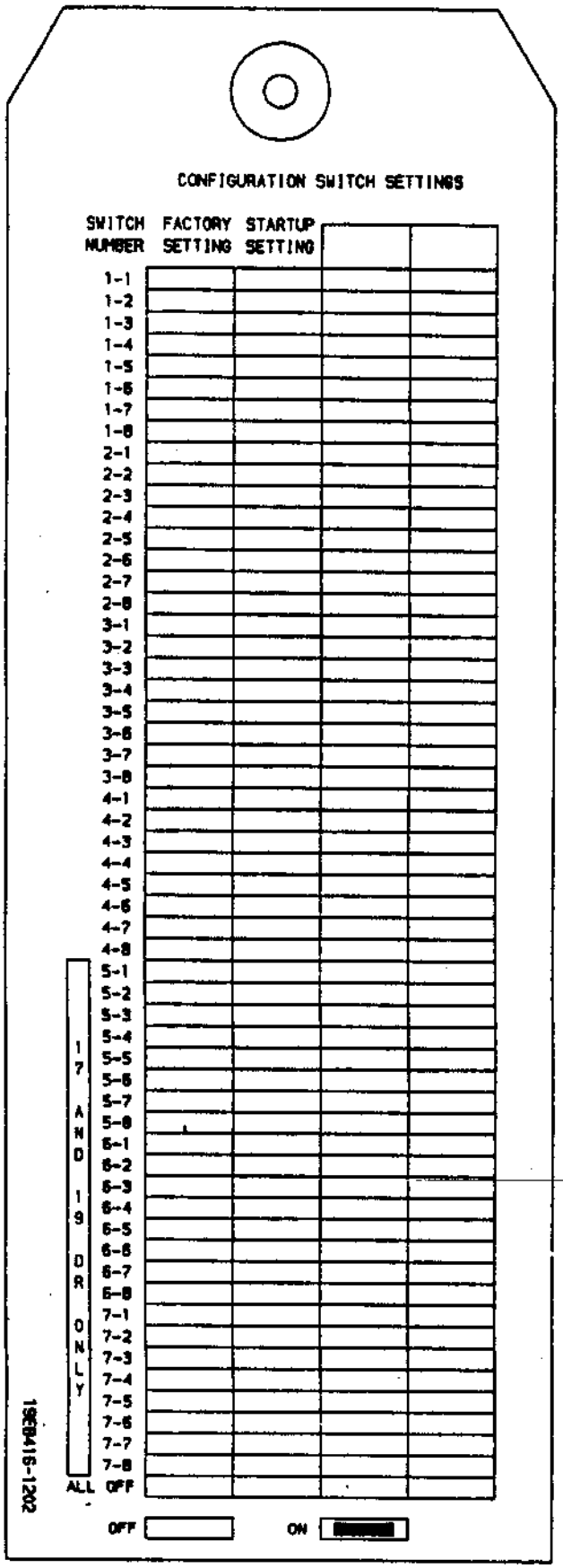
CONFIGURATION SWITCH SETTINGS
SWITCH NUMBER
FACTORY SETTING
STARTUP SETTING
1-1
1-2
1-3
1-4
1-5
1-6
1-7
1-8
2-1
2-2
2-3
2-4
2-5
2-6
2-7
2-8
3-1
3-2
3-3
3-4
3-5
3-6
3-7
3-8
4-1
4-2
4-3
4-4
4-5
4-6
4-7
4-8
5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
6-1
6-2
6-3
6-4
6-5
6-6
6-7
6-8
7-1
7-2
7-3
7-4
7-5
7-6
7-7
7-8
ALL OFF
17 AND 19 OR ONLY
OFF
ON
19EM16-1202

FIGURE 4

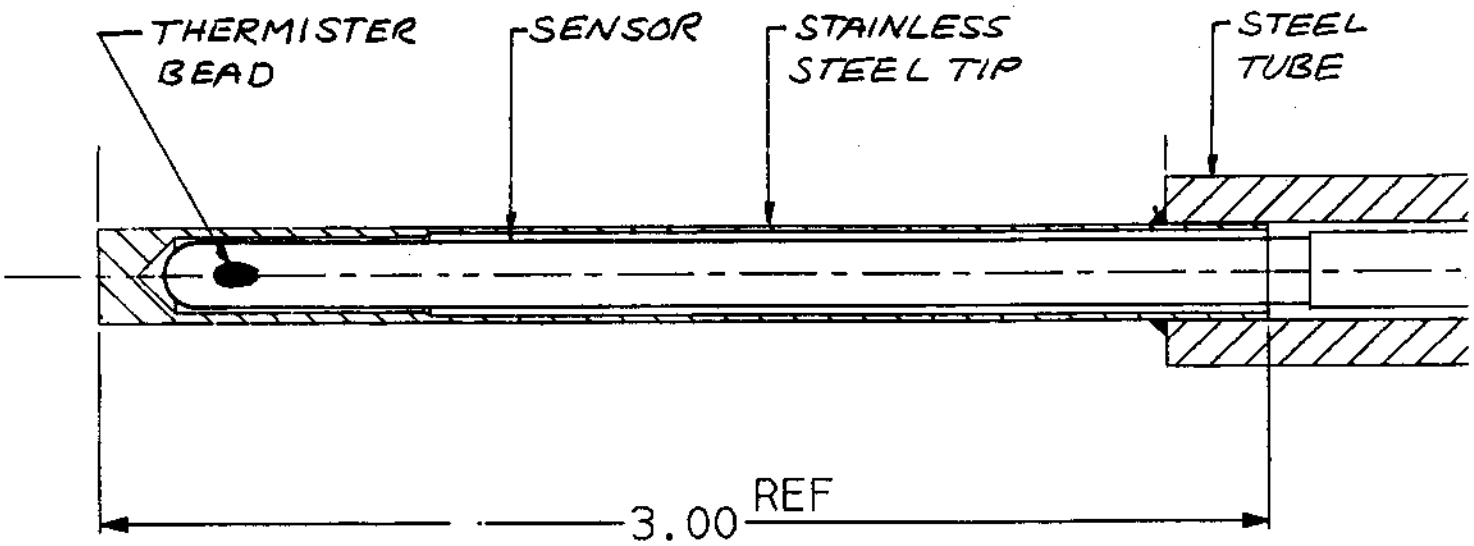
THERMISTER BEAD
SENSOR
STAINLESS STEEL TIP
STEEL TUBE
3.00 REF

TABLE I

SWITCH BANK	SWITCH POSITION	FUNCTION	SETTINGS	DESCRIPTION
1	1	TYPE OF MACHINE	0	NON-17/19DM
			1	17/19DM
	2	TYPE OF MACHINE	0	NON-19CB
			1	19CB
	3	LEAVING CHILLED WATER DEADBAND	0	1 DEG F DEADBAND
			1	2 DEG F DEADBAND
	4	LEAVING CHILLED WATER PROPORTIONAL BAND	0	5 DEG F PROP BAND
			1	15 DEG F PROP BAND
	5	LINE FREQUENCY	0	60 HZ
			1	50 HZ
	6	STARTER TYPE	0	REDUCED INRUSH
			1	FULL VOLTAGE
	7	MOTOR SENSOR TYPE	0	THERMISTER
			1	THERMOSTAT
	8	THRUST BEARING SENSOR TYPE	0	THERMISTER
			1	THERMOSTAT
2	1-3	CONTROLLER ID NUMBER	1 2 3	NUMBER
			0 0 0	0
			1 0 0	1
			0 1 0	2
			1 1 0	3
			0 0 1	4
			1 0 1	5
			0 1 1	6
			1 1 1	7
	4	FAHRENHEIT/CENTIGRADE DISPLAY	0	DEG F
			1	DEG C

SWITCH BANK	SWITCH POSITION	FUNCTION	SETTINGS	WIDTH INCHES	OLD COMP CODE	NEW COMP CODE
2	5-8	DIFFUSER WIDTH	5 6 7 8			
4	1-2		1 2			
			0 1 0 1 0 0	.44		
			1 1 0 1 0 0	.45		
			0 0 1 1 0 0	.46		
			1 0 1 1 0 0	.47		
			0 0 0 0 0 0	.48	42-47	
			0 1 1 1 0 0	.49		
			1 1 1 1 0 0	.50		
			0 0 0 0 1 0	.51		205,206
			1 0 0 0 1 0	.52		
			0 1 0 0 1 0	.53		
			1 1 0 0 1 0	.54		
			1 0 0 0 0 0	.55	49-54	
			0 0 1 0 1 0	.56		
			1 0 1 0 1 0	.57		225,226
			0 1 1 0 1 0	.58		
			1 1 1 0 1 0	.59		
			0 1 0 0 0 0	.60	56-61	
			0 0 1 0 0 0	.61	72-77	204,255,256
			0 0 0 1 1 0	.62		
			1 0 0 1 1 0	.63		
			0 1 0 1 1 0	.64		
			1 1 0 1 1 0	.65		224,315,316
			1 1 0 0 0 0	.66	63-68	285,286
			0 0 1 1 1 0	.67		
			1 0 1 1 1 0	.68		
			1 0 1 0 0 0	.69	79-84	
			0 1 1 1 1 0	.70		254
			1 1 1 1 1 0	.71		
			0 0 0 1 0 0	.72	B2-B7	305,306,355,356
			0 0 0 0 0 1	.73		314
			1 0 0 0 0 1	.74		284
			0 1 0 0 0 1	.75		
			0 1 1 0 0 0	.76	86-91	
			1 1 0 0 0 1	.77		405,406
			0 0 1 0 0 1	.78		
			1 0 1 0 0 1	.79		
			0 1 1 0 0 1	.80		
			1 1 1 0 0 1	.81		354
			0 0 0 1 0 1	.82		
			1 1 1 0 0 0	.83	93-98	455,456
			1 0 0 1 0 1	.84		
			0 1 0 1 0 1	.85		
			1 1 0 1 0 1	.86		
			0 0 1 1 0 1	.87		404
			1 0 1 1 0 1	.88		
			0 1 1 1 0 1	.89		
			1 1 1 1 0 1	.90		

0 - OFF 1 - ON

SWITCH BANK	SWITCH POSITION	FUNCTION	SETTINGS	WIDTH INCHES	OLD COMP CODE	NEW COMP CODE
2	5-8	DIFFUSER WIDTH	5 6 7 8			
4	1-2		1 2			
			1 0 0 1 0 0	.91	C2-C7	505,506
			0 0 0 0 1 1	.92		
			1 0 0 0 1 1	.93		454
			0 1 0 0 1 1	.94		
			1 1 0 0 1 1	.95		
			0 0 1 0 1 1	.96		
			1 0 1 0 1 1	.97		
			0 1 1 0 1 1	.98		
			1 1 1 0 1 1	.99		
			0 0 0 1 1 1	1.00		
			1 0 0 1 1 1	1.01		
			0 1 0 1 1 1	1.02		
			1 1 0 1 1 1	1.03		
			0 0 1 1 1 1	1.04		
			1 0 1 1 1 1	1.05		
			0 1 1 1 1 1	1.06		
			1 1 1 1 1 1	1.07		

		FUNCTION	SETTINGS	DESCRIPTION
3	1	CHILLED MEDIUM	0	WATER
			1	BRINE

		FUNCTION	SETTINGS	DIA CODE	DIA MULT	OLD COMP CODE	NEW COMP CODE
3	2-5	IMPELLER DIAMETER	2 3 4 5				
			1 0 1 1		1.799		
			0 0 0 1		1.712		
			1 0 0 1	2	1.556	42,49,56,63,B2 72,79,86,93,C2	3 DIGIT NUMBER ENDING WITH A 2
			0 0 0 0	3	1.442	43,50,57,64,B3 73,80,87,94,C3	3 DIGIT NUMBER ENDING WITH A 3
			1 0 0 0	4	1.303	44,51,58,65,B4 74,81,88,95,C4	3 DIGIT NUMBER ENDING WITH A 4
			0 1 0 0	5	1.212	45,52,59,66,B5 75,82,89,96,C5	3 DIGIT NUMBER ENDING WITH A 5
			1 1 0 0	6	1.142	46,53,60,67,B6 76,83,90,97,C6	3 DIGIT NUMBER ENDING WITH A 6
			0 0 1 0		1.056		
			0 0 1 1	7	1.012	47,54,61,68,B7 77,84,91,98,C7	3 DIGIT NUMBER ENDING WITH A 7
			1 0 1 0		0.975		
			0 1 1 0		0.845		
			1 1 1 0		0.756		
			0 1 0 1		0.674		
			1 1 0 1		0.601		

0 - OFF 1 - ON

SWITCH BANK	SWITCH POSITION	FUNCTION	SETTINGS	DESCRIPTION
3	6-8	RAMP LOADING RATE	6 7 8	RATE, DEG F PER MIN
			0 0 1	0.38
			1 0 0	0.75
			0 1 0	1.13
			1 1 0	1.50
			0 0 0	2.25
			1 0 1	3.00
			0 1 1	5.25
			1 1 1	10.5
4	1-2	SEE ABOVE		

SWITCH BANK	SWITCH POSITION	FUNCTION	ZONE	SF	DESCRIPTION
					3 4 5
4	3-5	COMPRESSOR SELECTION FACTOR	1	1.000	0 0 0
			2	0.958	1 0 0
			3	0.915	0 1 0
			4	0.873	1 1 0
			5	0.831	0 0 1
			6	0.789	1 0 1
			7	0.746	0 1 1
			8	0.704	1 1 1
4	6-8	MOTOR AMPS CORRECTION FACTOR	FACTOR		6 7 8
			1		0 1 0
			2		1 0 0
			3		0 0 0
			4		1 1 0
			5		0 0 1
			6		1 0 1
			7		0 1 1
			8		1 1 1

0 - OFF 1 - ON

TABLE II

MOTOR FACTORS FOR 19DK/DM/DR IDEAL MOTORS

	MOTOR CODE														
VOLT/HZ	AA	AB	AC	AD	AE	CA	CB	CC	CD	CE	CL	CM	CN	CP	CQ
200/60	5	3	4	4	2		4	5	3	6	3	2	3	2	2
208/60	6	3	5	5	4		5	5	5	8	4	2	4	2	2
220/60	2	1	3	2	2		3	4	2	2	2	3	1	1	1
230/60	3	2	5	3	4		5	6	4	4	3	5	2	2	2
240/60	5	1	7	4	5		5	6	4	4	3	8	2	2	2
360/60	2	3	6	8	4		4	2	4	2	2	2	1	1	1
380/60	4	5	6	3	2		7	4	6	4	4	5	3	2	2
400/60	5	6	8	4	4		7	5	8	4	4	5	3	2	3
440/60	2	2	3	3	2		3	3	2	2	1	1	1	1	3
460/60	3	3	5	5	4		5	4	3	2	2	2	2	2	5
480/60	5	5	7	6	5		7	5	4	3	3	3	3	3	7
550/60	2	2	2	4	3		4	2	3	2	1	2	3	2	2
575/60	4	4	3	6	4		4	4	4	2	2	3	4	3	3
600/60	5	5	5	7	5		8	5	6	4	3	4	6	5	4
3300/60						4	4	4	4	1	2	3	3	3	2
2400/60						4	4	4	3	3	2	3	2	2	3
4160/60						4	4	4	3	3	2	3	2	2	3
220/50	2	2	5	1	1		3	1	2	2	2	3	2	1	1
230/50	4	3	7	2	3		4	2	2	3	2	4	3	2	1
240/50	5	4	8	3	4		5	3	5	4	3	5	3	3	2
320/50	1	1	2	2	1		2	2	2	2	1	1	1	1	3
346/50	2	3	5	4	4		4	4	3	3	3	2	1	2	3
360/50	3	4	6	6	4		5	5	4	4	4	2	2	2	8
380/50	2	2	3	3	2		5	2	3	3	3	2	4	2	2
400/50	4	4	2	5	4		6	4	4	5	4	3	6	4	3
415/50	4	5	7	6	6		8	5	5	6	5	4	7	5	4
3000/50						3	3	2	2	3	2	3	1	2	1
3300/50						4	4	3	3	3	3	4	2	2	1
6000/50						5	5	5	4	4	4	4	4	4	4

TABLE II (continued)

MOTOR FACTORS FOR 19EB IDEAL MOTORS

	MOTOR CODE													
	DB	DC	DD	DE	DF	DG	DH	DJ	DK	DL	DM	DN	DP	DQ
200/60	2	4	3	3	2									
208/60	2	5	4	4	3									
360/60	2	2	1	1	2	1	1	1	1	1	1	1	1	
380/60	3	3	2	2	3	1	2	2	2	2	2	2	1	
400/60	5	4	3	3	4	2	2	2	2	2	2	2	2	
440/60	2	1	1	3	2	1	1	1	2	2	2	1	1	
460/60	3	2	2	4	3	2	1	1	3	2	3	1	1	
480/60	4	3	3	5	4	3	2	2	3	3	3	2	2	
550/60	3	2	1	1	2	1	5	1	1	2	1	1	1	
575/60	4	3	2	2	3	2	2	1	1	2	1	1	1	
600/60	5	4	3	3	4	3	3	2	2	3	2	2	2	
2400/60	2	3	2	2	2	3	4	3	1	1	2	2	1	1
3300/60	3	2	2	2	2	2	3	2	1	1	1	2	1	1
4160/60	2	3	2	2	2	3	4	3	1	1	2	2	1	1
6600/60			3	2	2	2	2	2	1	2	2	1	1	2
6900/60			4	3	3	3	3	3	2	3	2	2	2	2
7200/60			5	4	4	4	4	4	3	4	3	3	3	3
220/50	3	3	1	1	1	2	1							
230/50	4	4	1	2	1	3	1							
240/50	6	5	3	3	2	3	2							
320/50	3	3	1	1	1	1	1	1	1	1	1	1	1	
346/50	5	4	2	2	1	1	1	1	1	2	1	2	1	
360/50	7	6	3	3	2	1	2	2	2	2	2	2	2	
380/50	3	3	2	1	1	1	1	1	1	2	1	1	1	1
400/50	4	4	3	2	2	1	1	2	1	3	2	2	1	1
415/50	6	5	4	3	2	2	2	3	2	3	3	2	2	2
3000/50	2	3	3	2	2	1	1	1	1	2	2	2	1	2
3300/50	2	3	3	3	3	2	1	2	2	2	2	3	2	2
6000/50	4	3	2	2	2	2	2	2	2	1	2	1	1	1
6300/50	5	3	3	3	3	2	3	3	3	2	2	2	2	2
6600/50	6	5	4	4	5	3	4	4	4	3	3	3	3	3

TABLE II (continued)

MOTOR FACTORS FOR 17 DK/DM/DR SIEMENS MOTORS

	MOTOR CODE						
VOLT/HZ	E	F	G	H	J	K	L
200/60		4	4	5	4	2	4
230/60		4	4	5	4	2	4
380/60		4	4	5	4	2	4
460/60		4	4	5	4	2	4
575/60		4	4	5	4	2	4
2400/60			4	4	3	3	4
4160/60			6	6	6	6	5
200/50	4	4	4	1	3	4	4
400/50	4	4	4	1	3	4	4
3300/50			6	6	6	6	5