

# TechTopics No. 68

We are often asked for estimated heat generation data for our equipment. These requests are most common for our modern products, but we also have requests for data on the historic types D and F switchgear designs that used air magnetic circuit breakers. This issue of TechTopics provides information on these historic designs to allow calculation of approximate heat generated by the switchgear under assumed loading conditions.

The heat generation data in Tables 2 and 3 are based on full-rated continuous current. Actual heat generation estimates must consider the true loading of the equipment. The amount of heat generated is related to the square of the current, so a circuit breaker operating at one-half rated current will have heat generation only one-quarter of that at full rated continuous current. Because the effect of the square relationship is very significant, it is overly conservative to estimate heat generation based on the assumption that all sections and all circuit breakers each carry their rated continuous current at all times. Air conditioning systems sized based upon such estimates will be significantly larger than the real operating conditions require.

To estimate the heat generated under actual loading conditions, determine the component heat generation for each of the components indicated in Table 2 (type D) or Table 3 (type F). Estimated heat generation for circuit breakers should be adjusted for actual loading based on the ratio of the squares of the actual current and the rated current. To be precise, this adjustment should also be made for the actual current loading for the main bus in each individual vertical section, but this is frequently ignored in the interests of simplification. Instead, the main circuit breaker loading is usually assumed to be equal to the main bus loading in all vertical sections.

Example: Assume a lineup of type F switchgear with five vertical sections, one 2,000 A main breaker (loaded to 1,400 A), three 1,200 A feeder circuit breakers (loading 250 A, 600 A and 550 A), with 2,000 A main bus, and including space heaters. The lineup includes one voltage transformer (VT) rollout, one 10 kVA current power transformer (CPT) and non-complex electromechanical relaying (for example, three induction disk relays), and instrumentation (for instance, an ammeter with selector switch).

Heat generation estimation for historic switchgear type D (to 4.76 kV) and type F (to 15 kV) with air magnetic circuit breakers

The calculations would be as follows:

If true loading were not considered (for example, all calculations performed on the basis of full-rated current), the calculations would yield a heat generation of 8,420 watts, or about 170 percent of the "real" heat generation.

Category	Heat generation	
A	2,000 A circuit breaker at 1,400 A = $1,290 \times (1,400/2,000)^2 = 632$ W	
	1,200 A circuit breaker at 250 A = $910 \times (250/1,200)^2 = 39$ W	
	1,200 A circuit breaker at 600 A = $910 \times (600/1,200)^2 = 228$ W	
	1,200 A circuit breaker at 550 A = $910 \times (550/1,200)^2 = 191$ W	
Total heat generation for circuit breaker cells		1,090 W
B	Vertical sections with 2000 A bus at 1,400 A = $5 \times 210 \times (1,400/2,000)^2 =$	515 W
C	Space heaters for five vertical sections = $5 \times 500 =$	2,500 W
D	VT rollout = $1 \times 50 =$	50 W
E	CPT = $1 \times 4\% \times 10$ kVA =	400 W
F	Relaying and instrumentation = $4 \times 100 =$	400 W
Total estimated heat generation under assumed loading conditions		4,955 W

Table 1: Example

Category	Rated current	Continuous current - circuit breaker (rows 1-3) or main bus (row 4)			
		1,200 A	2,000 A	3,000 A	3,750 A
	Actual current	1,200 A	2,000 A	3,000 A	3,750 A
Circuit breaker cell with circuit breaker		750 W	1,050 W	2,390 W	3,520 W
Vertical section with main bus		100 W	150 W	310 W	480 W
Space heaters per vertical section		500 W	500 W	500 W	500 W
VT trunnion		50 W	50 W	50 W	50 W
CPT (drawout or stationary)		4% of CPT kVA rating	4% of CPT kVA rating	4% of CPT kVA rating	4% of CPT kVA rating
Relaying and instrumentation per circuit breaker cell	Microprocessor type	50 W	50 W	50 W	50 W
	Electromechanical non-complex	100 W	100 W	100 W	100 W
	Electromechanical complex	200 W to 300 W	200 W to 300 W	200 W to 300 W	200 W to 300 W

Table 2: Type D switchgear (to 4.76 kV) with type MA or type FA air magnetic circuit breakers - approximate full-load heat generation (in watts)

Category		Continuous current - circuit breaker (rows 1-3) or main bus (row 4)				
		Rated current	1,200 A	2,000 A	3,000 A	3,750 A
		Actual current	1,200 A	2,000 A	3,000 A	3,750 A
Circuit breaker cell with circuit breaker			910 W	1,290 W	2,390 W	3,520 W
Vertical section with main bus			140 W	210 W	310 W	480 W
Space heaters per vertical section			500 W	500 W	500 W	500 W
VT trunnion			50 W	50 W	50 W	50 W
CPT (drawout or stationary)			4% of CPT kVA rating	4% of CPT kVA rating	4% of CPT kVA rating	4% of CPT kVA rating
Relaying and instrumentation per circuit breaker cell	Microprocessor type		50 W	50 W	50 W	50 W
	Electromechanical non-complex		100 W	100 W	100 W	100 W
	Electromechanical complex		200 W to 300 W	200 W to 300 W	200 W to 300 W	200 W to 300 W

Table 3: Type F switchgear (to 15.0 kV) with type FB or type FC air magnetic circuit breakers - approximate full-load heat generation (in watts)

**Footnotes for Tables 2 and 3:**

- <sup>1</sup> Space heaters, when provided, are not normally controlled by a thermostat. Hence, their load is represented as a continuous load. The purpose of space heaters is to prevent condensation, and this is not limited by the absolute temperature. Even when a thermostat is used to control the heaters, it is set to shut the heaters off at a temperature of approximately 110° F. Therefore, in an air-conditioned room, the heaters would be energized continuously.
- <sup>2</sup> Heat generated by current transformers (CTs) is ignored as it is usually insignificant and varies according to the CT ratio as well as the loading.
- <sup>3</sup> The CPT heat generation estimate is very conservative and assumes that the CPT is operated at full-rated capacity. If normal loading is at less than full rating, heat generation may be adjusted by the square of the percent loading.
- <sup>4</sup> Relaying and instrumentation heat generation estimates are very approximate and are normally estimated based on the number of circuit breaker cells. Extensive relaying and instrumentation may warrant additional conservatism in the estimation of associated heat generation.
- <sup>5</sup> Conversion factor: watts x 3.415179 = BTU/hour.

▼

**For more information, please contact your local Siemens representative.**

Published by and copyright © 2009:  
Siemens AG  
Energy Sector  
Freyeslebenstrasse 1  
91058 Erlangen, Germany

Siemens Energy, Inc.  
7000 Siemens Road  
Wendell, North Carolina 27591 USA

For more information, contact  
+1 (800) 347-6659  
[www.usa.siemens.com/energy](http://www.usa.siemens.com/energy)

Siemens Energy, Inc.  
Order No. E50001-E710-A216-X-4A00

All rights reserved.  
Trademarks mentioned in this document are the property of Siemens AG, its affiliates or their respective owners.

Subject to change without prior notice.  
The information in this document contains general descriptions of the technical options available, which may not apply in all cases. The required technical options should therefore be specified in the contract.