

TechTopics Topic: Heat Generation Estimation for Type NXAIR P Switchgear (up to 15kV)

We are often asked to provide estimated heat generation data for our equipment. This issue of TechTopics provides information that allows calculation of approximate heat generated by the switchgear under assumed loading conditions.

The heat generation data given in the table is on the basis of full rated continuous current. Actual heat generation calculations must take into account 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 on such estimates will be larger than the real operating conditions require.

Approximate full load heat generation (in watts) for type NXAIR P Switchgear (up to 15kV)

Category	Rated current	1200A	2000A	3000A	4000A
	Actual current	1200A	2000A	3000A	4000A
Circuit breaker cell, with circuit breaker		605W	1350W	2250W	3500W
Forced air cooling fan (4000A circuit breaker cells only)		---	---	---	75W
Vertical section, with main bus		195W	250W	350W	550W
Space heaters, per circuit breaker cell	200W				
Space heaters, per auxiliary cell	100W plus 100W for each rollout tray				
VT rollout	50W				
CPT (drawout or stationary)	4% of CPT kVA rating				
Relaying and instrumentation, per circuit breaker cell:	50W				
• Microprocessor type					

Notes on assumptions:

- 1 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.
- 2 Heat generated by current transformers is ignored as it is usually insignificant, and varies according to the CT ratio as well as the loading. The data above includes the maximum number of CT cores per circuit breaker compartment.
- 3 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.
- 4 Relaying and instrumentation heat generation estimates are very approximate. Extensive relaying and instrumentation may warrant additional conservatism in the estimation of associated heat generation.
- 5 Conversion factor: watts X 3.415179 = BTU/hour.

To estimate the heat generated under actual loading conditions, determine the component heat generation for each of the components indicated in the table. 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 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 with six vertical sections, one 3000A main breaker (loaded to 2150A), four 1200A feeder breakers (loading 850A, 250A, 600A, and 450A), with 3000A main bus, and including space heaters. The lineup includes one VT rollout, one 10kVA CPT rollout, and microprocessor relaying and instrumentation. The calculations would be as follows:

Category	Heat Generation	
A	3000A breaker at 2150A = $2250 \times (2150/3000)^2 =$	1155 W
	1200A breaker at 850A = $605 \times (850/1200)^2 =$	304 W
	1200A breaker at 250A = $605 \times (250/1200)^2 =$	26 W
	1200A breaker at 600A = $605 \times (600/1200)^2 =$	151 W
	1200A breaker at 450A = $605 \times (450/1200)^2 =$	85 W
	Total heat generation, circuit breaker cells	1721 W
B	Forced air cooling fan (4000A circuit breaker cell only)	---
B	Vertical sections w/3000A bus at 2150A = $6 \times 350 \times (2150/3000)^2 =$	1079 W
C	Space heaters for 4 circuit breaker cells = $5 \times 200 =$	1000 W
	Space heaters for 1 auxiliary cell with two rollouts = $100 + (2 \times 100) =$	300 W
D	VT rollout = $1 \times 50 =$	50 W
E	CPT = $1 \times 4\% \times 10\text{kVA} =$	400 W
F	Relaying and instrumentation = $5 \times 50 =$	200 W
	Total estimated heat generation under assumed loading conditions	4750 W

If true loading were not considered, (i.e., all calculations performed on the basis of full rated current), the calculations would yield a heat generation of 8720 watts, nearly double the “real” heat generation.

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