Jackson Barracks 141st Field Artillery Battalion Readiness Center

ATRIUM SMOKE REMOVAL CALCULATIONS

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35% Design Submittal

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Smoke System Activation Time:

The following formulas are from NFPA-92B equation #3. Based on experimental data the approximate activation time of the smoke control system initiation devices can be approximated. The purpose of determining the response time of the activation system is to determine the fire size. Since the building is protected by an automatic sprinkler system, it can be assumed that the fire size at sprinkler will not change.

T=	144	temperature increase to activate smoke system in seconds
H=	55	ceiling height above fire surface in feet
Q=	1000	heat release rate of fire in BTU/s

Y=T*(H^(5/3))/(Q^(2/3))= 1145.426

X=((4.6EE10^-4)*Y^2)+((2.7EE10^-15)*Y^6)= 6701.213952

t=(X*H^(4/3))/(Q^(1/3))= 140164.2 seconds

Based on this response time and Figure C-3, a 1000 BTU/s fire size must be assumed for the atrium fire size.

Smoke Layer Depth at Detector Activation:

The following formulas are based on NFPA-92B equations #8 and #9.
The Zd indicates the level of the smoke at the time of initial indication. Hmax is the maximum ceiling height that a smoke plume of fire size Qc can reach without stratifying.

Qc=.7*Q=	700	convective heat release rate in BTU/s (Q=1000 BTU/s)
To=	50	difference between temperature at fire surface and ceiling in degrees F
A=	320	cross-sectional area of atrium in ft^2

Hmax=74*(Qc^(2/5))*(To^(-3/5))= 97.24985 feet **TRUE** smoke will not stratify prior to reaching ceiling

Axisymmetric Plume Airflow Requirements:

Based on equation #14 and #16 in NFPA-92B as calculated below, the smoke generation rate of a 1000 BTU/s fire in the atrium can be approximated. The amount of exhaust airflow required is equal to the smoke generation rate.

Z=	50	height above the fuel in feet

z1=.533*Qc^(2/5)= 7.324305 limiting elevation of flame height in feet

m=.022*Qc^(1/3)*Z^(5/3)+(.0042*Qc)= 135.4978245 lb/sec

V=60*m/p= **108398.3 cfm**