

**Thermal Management Requirements**  
**High Heat Equipment In The Central Office**

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**1. GENERAL**

**A. Scope**

1.01 This section provides guidelines for the installation of high heat electronics equipment in the central office environment. The guidelines shall be followed to reduce risks of exceeding building cooling capacity that may lead to failure of equipment in the central office. The guidelines shall be applied for telephone company equipment, collocated equipment and any other equipment in the central office equipment environment.

**B. Background**

1.02 The trend for network, data, and internet electronics equipment is denser, faster, increased service capabilities leading to very high power draws and a greater amount of heat being released into the room. Heat release rates of individual pieces of equipment are approaching values 20 times greater than what was common for network equipment in the mid 1990's.

1.03 Building cooling capacity cannot be easily increased in traditional layouts of central offices due to air distribution limitations. Overhead air diffusers supplying cooling air to equipment are restricted by duct size and shared space with cable rack runs.

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### **C. Heat Density**

- 1.04 The heat dissipation load from equipment over an established floor footprint will be called the heat density. The heat density will be in units of Watts/square foot and the limits are based on designed building cooling capacity.
- 1.05 Heat dissipation may be provided in BTU/hr. by equipment manufacturer and can be converted to Watts by multiplying BTU/hr. times 0.2928.
- 1.06 Heat density discussed is for immediate equipment space, i.e. switching equipment room, transport equipment space, and does not include areas in the building where no active equipment is placed or administrative space. Therefore, when discussing actual building cooling capacity, the heat density will be significantly lower.

### **C. Organization Responsibilities**

- 1.07 Groups within SBC that have responsibilities with equipment heat dissipation include technology introduction organizations, product environmental review team, space planners, corporate real estate, facilities management, equipment engineers.
- 1.08 Each group has responsibilities that must be performed to assure the installation of high heat equipment does not affect the reliability of the network and/or determine the most economical measures to deploy high heat equipment.
- 1.09 It is the responsibility of the technology introduction organizations to determine if the product being considered, as early as the approval for use phase, will be high heat equipment and if so, what will be the most economical way to deploy the product using measures described in this document to manage heat dissipation, see Figure 1. Refer to Section 5 for space analysis procedures.
- 1.10 Corporate real estate and facility managers shall be advised by technology introduction organizations to create special environments to accommodate high heat density spaces if it is determined to be beneficial to create these areas.
- 1.11 Equipment engineers shall adhere to deployment requirements specified on Product Approval Notices (PAN's), space planner notifications or product environmental reviews (NEBS) for any thermal management considerations.
- 1.12 The placement of the high heat equipment will impact the building cooling requirement, (a concern of CRE), as well as equipment floor space requirements, (a concern of CSSP). Careful deployment techniques must be provided to the CRE and CSSP's by technology introduction organizations. The deployment guide shall include special cooling arrangements, if any, and the spacing requirements (equipment size, suggested number of shelves per rack, spacing between racks, special location).

## 2. EQUIPMENT

### A. High Heat Equipment

- 2.01 High heat equipment is defined to be any single equipment shelf, cabinet, cardcage, or multiple unit system, installed in framework(s) where the total heat dissipation exceeds the established heat density limit of 100 Watts/square foot.
- 2.02 Heat dissipation values are provided by the equipment manufacturer based on power consumed by the equipment during continuous duty operation less the useful output the equipment generates. These values may be measured or calculated by the manufacturer on typically configured equipment and may not reflect actual field measured equipment numbers.
- 2.03 **The method of determining Watts/square foot:**
- a) Minimum aisle spacing for traditional equipment areas in central offices is 2'-6" front aisle and 2'-0" rear aisle. Wider aisles are recommended, however, in practice the narrower aisles are being followed in most central offices, therefore the minimum aisle dimensions shall be used for heat calculations. Aisles are shared with equipment in adjacent lineups, only one-half of the aisle space is used in determining footprint of equipment in square foot.
  - b) For the purpose of calculating heat release of equipment in a framework, we shall use a nominal frame depth of 24" that typifies a depth between the 15 inches and 36 inches equipment depth found in SBC central offices and one-half of front and rear aisle space.
  - c.) Determine equipment footprint by multiplying equipment depth and aisle depth by the equipment width as shown in Figure 2.
- 2.04 In general, any equipment going into a traditional equipment lineup of open frameworks in central offices would be limited to no more than 850 Watts total heat release for all equipment in one framework. Any combination of single shelf or multiple shelves in the one frame whose heat release combines for a total over 850 Watts would be considered high heat.
- 2.05 Heat release is defined as power current draw measured at normal operation of equipment minus the current of useful work out. For some equipment, the work out can be measured to determine the heat. However, other equipment's useful work may not be easily measured and an assumption of 90% of power current draw at normal operation may be used to estimate heat release. Heat released will vary for different equipment and will not be uniform in an equipment area.
- 2.06 Equipment shall be configured as intended for field installation when determining heat release data. Continuous duty operating conditions shall be used for determining heat load and not worst case peak conditions.

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- 2.07 Equipment identified as “high heat” when evaluated for SBC TP76200 (environmental and safety) compliance will be listed on a common systems database. The database is accessed on the Common Systems internal website at <http://home.sbc.com/commonsystems/products/index.html>.
- 2.08 All high heat equipment shall be provided floor space for heat release of that equipment to stay within the 100 Watts/square foot heat density limits.
- 2.09 Floor space provided adjacent to equipment framework to maintain heat density shall be defined as “thermal management” space and becomes non-assignable or not available for installation of future equipment so long as the high heat equipment is in service.

### **B. Equipment Systems**

- 2.10 Network services or data services provided by multiple pieces of equipment mounted in more than one framework may have the total system heat release averaged over footprint of all frames of that system. One framework of equipment may have total heat release exceeding footprint allowable of 100 Watts/square foot so long as average heat density of all frames of the system is within heat density limits.
- 2.11 The total heat release of multiple pieces of equipment required to provide a service in one frame could exceed maximum heat load allowed so long as “thermal management” space is provided adjacent to the equipment frame to keep heat release within heat density limits.
- 2.12 Vacant frame space may be available for physically installing other equipment in a frame limited by heat release, that space shall not be used to install other active heat generating equipment. Passive, non-powered, equipment or apparatus may be installed to fill those vacant spaces, (examples DSX-1, patch panels, bookshelves, etc.).
- 2.13 Equipment manufacturer should be advised to package systems for heat release compliance as well as functional considerations.

## **3. CENTRAL OFFICE COOLING**

### **A. Traditional Equipment Space**

- 3.01 Traditional central office equipment areas are designed with cooling air to be distributed from overhead diffusers. Low pressure ducts bring chilled air into the equipment space and smaller branch ducts are provided to distribute air to lower levels and around obstructions.
- 3.02 Diffusers are positioned above equipment fed by branch ducts at 11’-6”, 9’-0” or 7’-0” height. Fan forced air is directed down to the floor level from the diffusers.

- 3.03 Air diffusers must clear overhead auxiliary framing, cable rack, cables and light fixtures or airflow may not reach equipment. Some equipment may not get cooling air due to overhead obstruction.
- 3.04 Airflow from diffusers is governed by air velocity rates, acceptable noise levels and temperatures so equipment may not always get the cooling air it needs.
- 3.05 Traditional equipment environments is limited to heat density of 100 Watts/square foot in the immediate equipment area and 40-50 Watts/square foot when averaged over the entire central office space. The lower heat density accounts for central office space where heat loads are lower or space where no active equipment is placed.

**B. Special Equipment Space**

- 3.06 Special equipment space is an environment where arrangements have been made for additional cooling capacity or air distribution has been provided by facilities managers to accommodate heat densities above 100 Watts/square foot.

**a. Isolated Equipment Rooms**

High heat equipment that is installed in a partitioned space away from existing network technologies may be able to be installed at greater heat density than 100 Watts/square foot if the greater heat load and subsequent greater room temperatures does not impact other network equipment.

Limits for heat density will rely upon cooling capacity provided for the space and tolerance of high heat equipment to increased ambient temperatures. All equipment built in conformance to NEBS requirements should be able to operate continuously at ambient temperatures of 30°C to 50°C.

**b. Enhanced Air Distribution**

Improved air distribution of cooling air to equipment whether locally to specific equipment or throughout the equipment space may permit greater heat density to be applied. Air distribution is the delivery of chilled air to equipment level of all equipment and the return of mixed chilled and heated exhaust air from equipment.

Chilled air introduced locally to specific equipment may result in overall ambient room temperature to rise if removal of heated air from that equipment has not been increased through room return air system.

Distribution of cooling air with methods such as displacement cooling may permit greater heat density in space. Equipment lineups must be configured for airflow from wall diffusers to run length of room and room length may be limited to about 40 feet maximum with one wall of diffusers.

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### **c. Raised Floor Systems**

Raised floor system environments move cables from over head to under the floor thereby freeing overhead space for additional air diffusers and larger ducts.

For network equipment, use only floor system designs that permit securing equipment frames to building and seismic risk conditions at office location.

Floor systems with underfloor space dedicated to cable distribution shall not use space for ductless cooling air distribution, also known as air plenum duty. Floor rating shall be affected and plenum duty cables become necessary.

Equipment environment with cables under the floor and overhead diffusers may increase heat density allowables with the improved cooling air distribution.

### **d. Raised Floor Air Plenum**

A raised floor system provided for distribution of cooling air to equipment may increase heat density by up to three times under certain conditions. These conditions may result in an environment less comfortable for long term personnel occupancy due to higher noise, airflow rates and lower temperatures.

Raised floor plenum system shall not be used for cable distribution in underfloor space. Airflow patterns may be affected by cable pileups.

### **e. Chilled Liquid Cooling**

Equipment provided with heat exchangers for removal of heat by liquid coolant with very little heat introduced into the room may allow greatly increased heat density since heat released by equipment does not affect room ambient temperature.

Liquid coolant requires routing pipes and hoses to equipment heat exchangers. There is a minimal risk for leakage of coolant and therefore coolant introduced into the equipment space shall be very low toxicity, low corrosion, and non-conductive material.

Pipes and hoses shall never be routed over equipment. Pipes and hoses shall be run under equipment with equipment on a raised floor system.

Heat exchangers may be provided at equipment housing or as part of the framework where electronics are installed and exhausted heated air is transferred to framework mounted heat exchanger.

### **f. Heat Exhaust Systems**

Overhead negative draft duct system with hood for removing heat dissipated by equipment convection may permit increased heat density by allowing purging of heat from room. Effectiveness of negative draft duct system would depend on placement of hood and flow of exhausted heat from equipment.

Sealed cabinet framework with exhaust ductwork to remove dissipated heat of equipment in cabinet may permit increased heat density in room.

**C. Equipment Space Heat Density**

Heat density limits may be increased under special circumstances when equipment area has been designed and constructed to accommodate the higher heat loads by enhanced air distribution or room architecture.

Heat density limits are possible as shown in Table 1. It should be noted that room conditions may be objectionable for long term personnel occupancy in some of the special environments due to greater noise, higher airflow and lower room temperatures.

**Table 1  
Heat Density Allowables  
Per Equipment Environment**

<i>Equipment Environment</i>	<i>Heat Density</i>	<i>Occupancy Conditions</i>
Traditional Equipment Space	100 Watts/sq.ft.	None
Isolated Equipment Rooms	150 Watts/sq.ft.	Higher temperatures
Enhanced Air Distribution	>100 Watts/sq.ft.	Higher noise and air velocity
Raised Floor Systems	150 Watts/sq.ft.	None
Raised Floor Air Plenum	300 Watts/sq.ft.	Higher noise, air velocity, lower temp
Liquid Cooling	>300 Watts/sq.ft.	None
Heat Exhaust Systems	200 Watts/sq.ft.	Higher noise and air velocity

**4. SPACE PLANNING**

**A. Equipment Layout**

4.01 High heat equipment shall be installed occupying required floor space for maintaining heat density of equipment environment. Any adjacent floor space required as “thermal management” space shall be designated on drawings and records.

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- 4.02 SBC equipment lineups typically are designed for company standard 15 inch or less depth or 36 inch or less depth. The 24 inch equipment lineup fits within the accepted 36 inches or less depth footprint for equipment that does not need the 36 inch depth provided in the large footprint design. 24 inches shall be considered the minimum lineup depth for high heat equipment installed in the central office.
- 4.03 For special equipment space as defined in previous paragraphs, higher heat density may be available.
- 4.04 When additional “thermal management” floor space requirements are necessary, the drawings of installation of the high heat area shall show space designated for thermal management purposes and no future equipment shall be placed in those spaces so long as high heat equipment is in service. The drawing must clearly label floor space as “thermal management” space”.
- 4.05 Empty framework or cable extenders installed adjacent to high heat equipment framework physically reserves “thermal management” space from inadvertent utilization of area. Empty framework shall be installed with blank plates or passive equipment to avoid future installation of active equipment.

### **B. Floorspace Management**

- 4.06 High heat equipment in the traditional equipment environment is accommodated by use of additional floorspace to maintain allowable heat density. Increasing footprint dimensions of high heat equipment reduces heat density.
- 4.07 Footprint may be increased by adding width to high heat equipment framework, (increasing frame width with spacers) or by adding depth, (increasing front and rear aisles).
- 4.08 Increasing equipment footprint when high heat equipment exists shall be applied in increments to maintain heat density in a traditional environment of 100 Watts/square foot by using the following guide:

#### **a. Increasing footprint width**

Five inch wide cable spacer between high heat framework and adjacent framework provides additional 1.75 square foot and up to 175 Watts to total of high heat frame.

Two five inch wide cable spacers on each side of high heat framework provides additional 3.5 square foot and up to 350 Watts to total of high heat frame.

Adding one framework adjacent to high heat framework provides additional 8.5 square foot and up to 850 Watts to total of high heat frame.

**Table 2**  
**Maximum Heat Load Allowed Per Frame (Watts)**  
**Increasing Footprint Width**  
 At Heat Density of 100 Watts/sq.ft.  
 Equipment Depth 2'-0", width 2'-1"  
 2'-6" Front Aisle, 2'-0" Rear Aisle

	<b>Add (1) 5" Cable Spacer</b>	<b>Add (2) 5" Cable Spacers</b>	<b>Add Adjacent Framework</b>
Max. Watt	850 + 175 = <b>1025</b>	850 + 350 = <b>1200</b>	850 + 850 = <b>1700</b>

Increasing footprint width with additional framework may be the most common method as framework may be used to house passive equipment or equipped with trays, drawers or bookcases. High heat equipment may require multiple additional frameworks to reduce heat density of equipment to allowable limits as shown on Figure 3.

**b. Increasing footprint depth**

Footprint depths are changed by increasing aisle dimensions between adjacent equipment lineups. Some newer technology equipment may be deeper than 24 inches and require increased equipment dimension depths increasing overall footprint and slightly greater heat load allowables.

**Table 3**  
**Maximum Heat Load Allowed Per Frame (Watts)**  
**Increasing Footprint Depth**  
 At Heat Density of 100 Watts/sq.ft.  
 Equipment Depth 2'-0"

Rear Aisle Width	Front Aisle Width		
	2'-6"	3'-0"	4'-0"
2'-0"	850	900	1000
2'-6"	900	925	1050
3'-0"	950	1000	1100

**Table 4**  
**Maximum Heat Load Allowed Per Frame (Watts)**  
**Increasing Footprint Depth**  
 At Heat Density of 150 Watts/sq.ft.  
 Equipment Depth 2'-0"

Rear Aisle Width	Front Aisle Width		
	2'-6"	3'-0"	4'-0"
2'-0"	1275	1350	1500
2'-6"	1350	1425	1575
3'-0"	1425	1500	1650

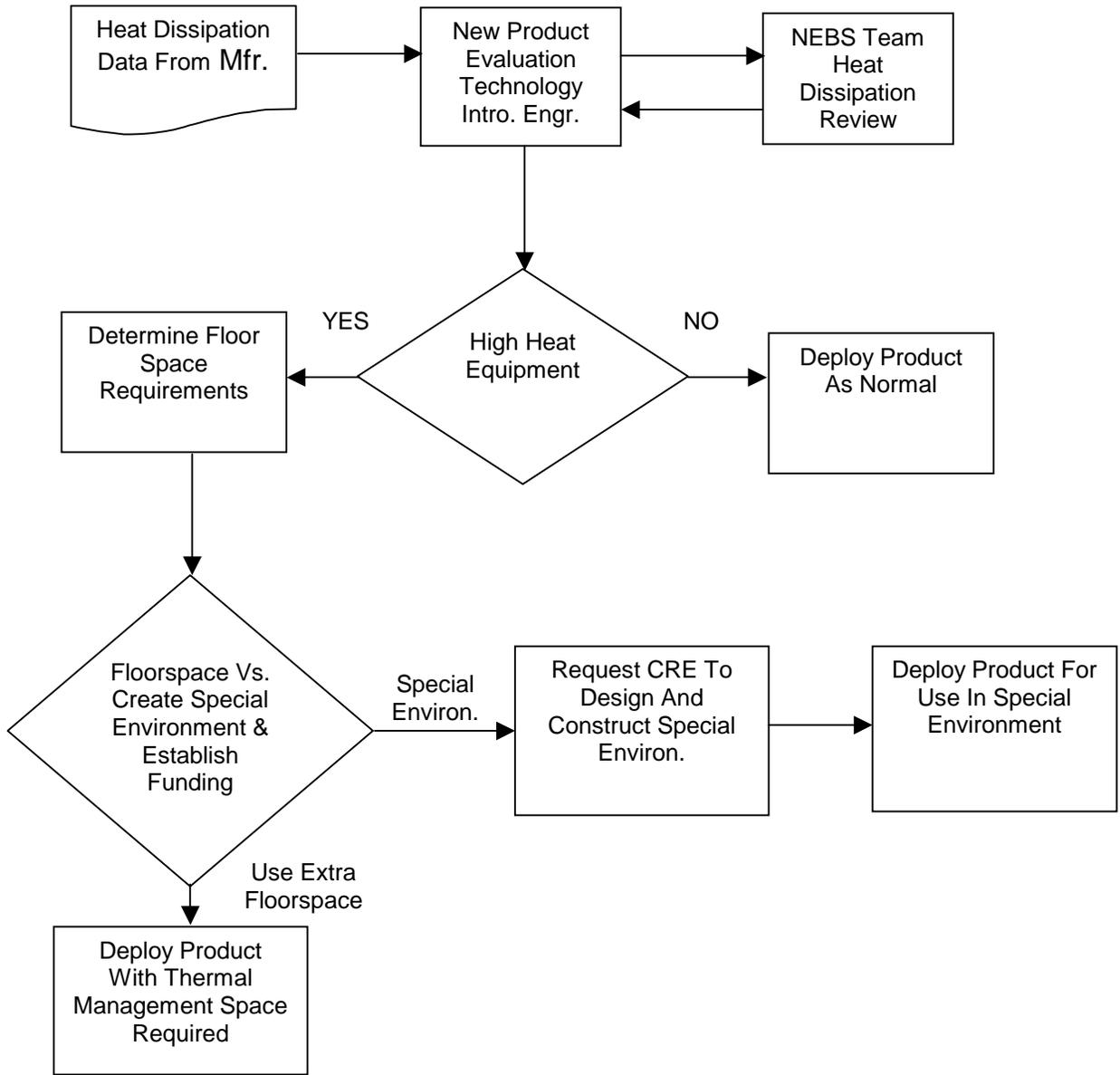
## **Iss. A, BSP 800-003-101MP**

### **C. Site Specific Audits**

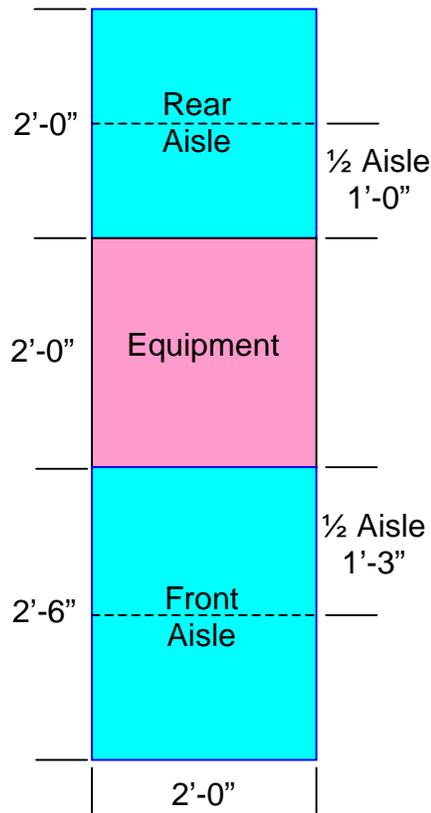
- 4.09 High heat equipment may be installed without providing additional floorspace in an equipment room if the overall heat load of a space can be determined to be within the 100 Watts/square foot. Existing equipment in the room may be much less than maximum heat density and margin is available for high heat equipment.
- 4.10 Audit conducted at the specific site through measurement or manufacturer data shall be used to determine existing overall heat load.

### **5. FLOOR SPACE ANALYSIS**

- 5.01 It may be determined that the increased footprint for thermal management may not be as cost effective as establishing special equipment environments. At some high heat heat load condition the required increased footprint will become economically impractical.
- 5.02 Products exceeding 5000 Watts heat release using current increased footprint measures require footprint equal to 6 frameworks and more. The floor space footprint requirements in this example is based on minimum aisle widths and 2 feet equipment depth.
- 5.03 Technology introduction engineers shall determine during very early review phase whether the need for large “thermal management” floor space is acceptable or whether special environments shall be constructed to reduce floor space requirements as well as procuring funds for construction of that environment.
- 5.04 Technology introduction engineers shall work with equipment manufacturers in determining the expected heat loads of the most likely equipment configurations when deployed to assure heat data will be available in performing space analysis.
- 5.05 The floor space analysis shall consider the costs of annual floor space expenses for life of product installation compared with costs to construct special environments for reduced floor space use.
- 5.06 Requirements for how the product is to be deployed shall be documented in product approval notice for space planning purposes. The recommendations may state special environments to be required in order to reduce floor space use, therefore creating need for specific office modifications to accommodate product.
- 5.07 Corporate real estate or facility managers shall be advised of the need to design and construct special environments to house high heat equipment when determined to be necessary.



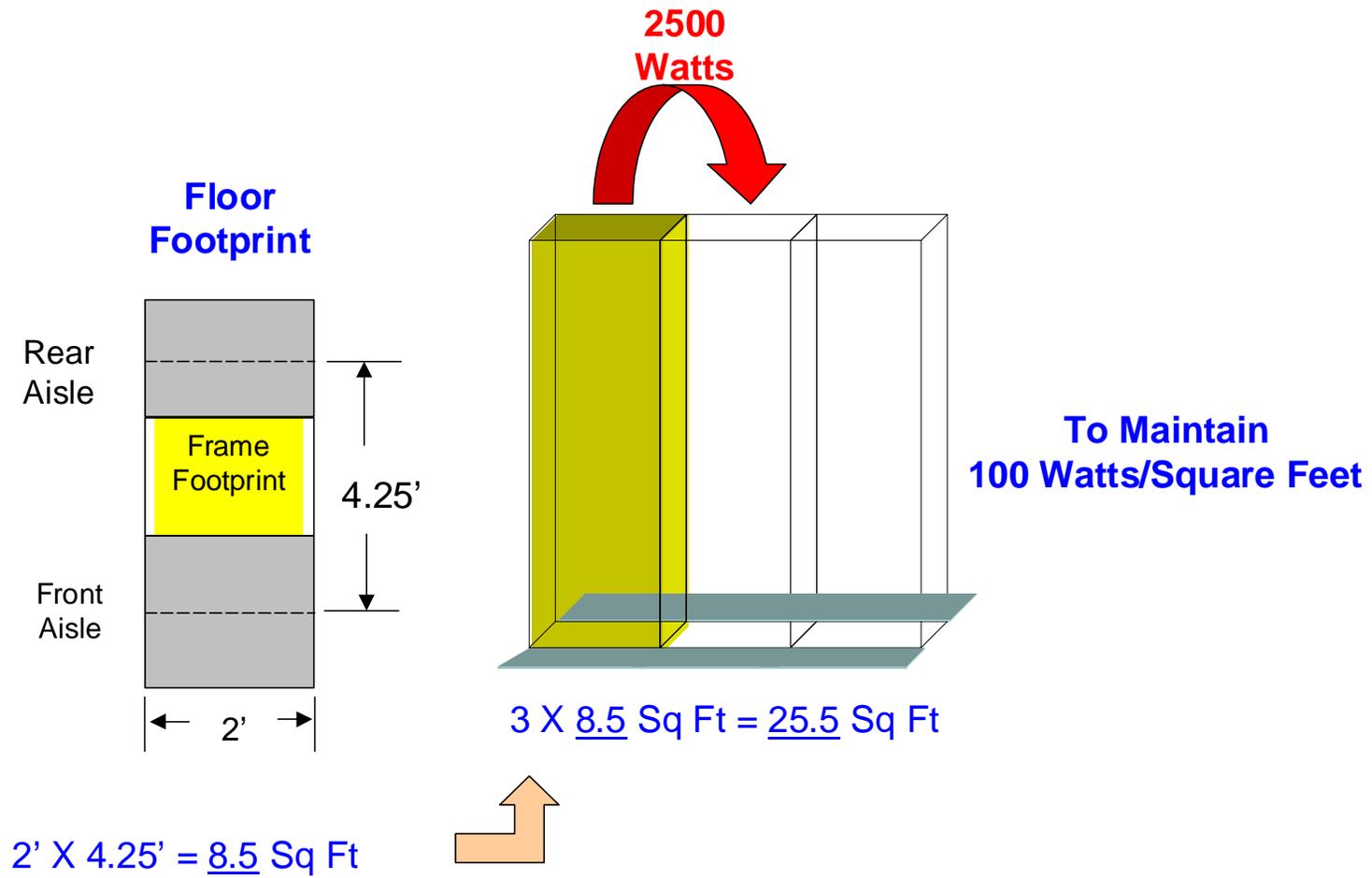
**Figure 1**  
High Heat Equipment Application Flowchart



Equipment depth + 1/2 front aisle depth + 1/2 rear aisle depth X Equipment width

$$(2'-0" + 1'-3" + 1'-0") \times 2'-0" = 8.5 \text{ square feet}$$

**Figure 2**  
Determining Equipment Footprint



**Figure 3**  
Using Footprint To Maintain Heat Density