Central Station Air Handlers

Technical Development Program
Technical Development Programs (TDP) are modules of technical training on HVAC theory, system design, equipment selection and application topics. They are targeted at engineers and designers who wish to develop their knowledge in this field to effectively design, specify, sell or apply HVAC equipment in commercial applications.

Although TDP topics have been developed as stand-alone modules, there are logical groupings of topics. The modules within each group begin at an introductory level and progress to advanced levels. The breadth of this offering allows for customization into a complete HVAC curriculum – from a complete HVAC design course at an introductory-level or to an advanced-level design course. Advanced-level modules assume prerequisite knowledge and do not review basic concepts.

Air handlers do not just handle air. They also cool, heat, filter, and humidify. Central station air handlers are typically “built to order” with a wide variety of available options and accessories to choose from. Central station air handlers are available factory-designed for indoor use or for rooftop mounting. This TDP module will explain the types of equipment and the sectional components that comprise an air handler, both indoor and outdoor types, discuss modern construction methods for central station air-handling units, as well as the software programs used for selection.

© 2005 Carrier Corporation. All rights reserved.

The information in this manual is offered as a general guide for the use of industry and consulting engineers in designing systems. Judgment is required for application of this information to specific installations and design applications. Carrier is not responsible for any uses made of this information and assumes no responsibility for the performance or desirability of any resulting system design.

The information in this publication is subject to change without notice. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, for any purpose, without the express written permission of Carrier Corporation.

Printed in Syracuse, NY
CARRIER CORPORATION
Carrier Parkway
Syracuse, NY 13221, U.S.A.
# Table of Contents

- **Introduction** .................................................................................................................. 1  
- Packaged, Central, and Custom Air Handlers .................................................................. 2  
- Packaged Air Handlers ..................................................................................................... 2  
- Central Station Air Handlers ............................................................................................. 3  
- Custom Air Handlers ......................................................................................................... 3  
- Selection Basis for Central Station and Custom Air Handlers ........................................ 4  
- Basic Air Handler Unit Construction ............................................................................. 5  
  - Post and Panel Design .................................................................................................... 5  
  - Structural Panel Design ................................................................................................. 6  
  - Casing Design and Materials ........................................................................................ 6  
  - Antimicrobial Coatings ................................................................................................. 7  
  - Insulation Types ............................................................................................................. 8  
  - Single-Wall vs. Double-Wall ......................................................................................... 9  
  - Seals ............................................................................................................................... 11  
- Air Handler Types ............................................................................................................. 12  
  - Indoor Units .................................................................................................................... 12  
  - Outdoor Units ................................................................................................................ 13  
  - Draw-Thru and Blow-Thru ............................................................................................ 14  
- Coils .................................................................................................................................. 15  
  - Types and Construction ................................................................................................. 15  
  - Drain Pan ....................................................................................................................... 16  
  - Condensate Drain Trapping .......................................................................................... 16  
- Fan Section Characteristics and Performance .............................................................. 18  
  - Supply Fan ...................................................................................................................... 18  
  - Return Fan ...................................................................................................................... 19  
  - Exhaust Fans .................................................................................................................. 19  
  - Fan Discharge Arrangements ......................................................................................... 20  
- Centrifugal Fan Types ..................................................................................................... 20  
  - Forward-Curved Impeller .............................................................................................. 21  
  - Backward-Inclined Impeller .......................................................................................... 21  
  - Airfoil .............................................................................................................................. 22  
  - Plenum Style .................................................................................................................. 22  
- VAV Fan Volume Control ................................................................................................. 22  
  - Riding the Fan Curve ...................................................................................................... 23  
  - Inlet Guide Vanes .......................................................................................................... 23  
  - Discharge Dampers ......................................................................................................... 24  
  - Variable Frequency Drives ............................................................................................ 24  
- AMCA Fan Class ............................................................................................................... 24  
- Fan Components ............................................................................................................... 25  
  - Fan Mounting ................................................................................................................ 25  
  - Discharge Isolation ......................................................................................................... 26  
  - Bearings ......................................................................................................................... 26  
  - Drives .............................................................................................................................. 28  
  - Motors .............................................................................................................................. 28
Introduction

Factory-assembled central station air-handling units are generally one of the first items of air-conditioning equipment selected after the cooling load estimate is completed. In the system design process, a chilled water or refrigerant temperature level is established under which the chiller or condensing units will operate. In turn, this temperature is used to determine the design requirements for the air-handling equipment, including coils and fans. Because of its effects on other system components, it is imperative for the designer to have a thorough understanding of central station air-handling equipment and how it should be selected and applied.

Figure 1

Where does the air handler fit in?

This TDP will outline the basic construction methods used in current central station air-handling units, the types of fans and their characteristics, common methods to modulate fans when used in VAV systems, and indoor air quality (IAQ) air-handling unit components like energy recovery and filtration sections.

Increasing concern about building health conditions and ventilation requirements has made IAQ a top consideration in today’s HVAC equipment purchases. For air handlers, in addition to delivering conditioned air in the proper quantities and temperatures, effective filtration, minimal air leakage, energy efficiency and improved serviceability are also critical. As a result, the designer can no longer focus attention exclusively on the coil and fan selections. Casing design and performance should also be considered from the standpoints of thermal performance, air leakage, and serviceability. Therefore, this TDP module will explain both the components that make up an air handler, and how they are constructed.

Manufacturers are developing new products and integrating new materials and technologies to address these needs. More and more, features that were once available on “custom” units are being incorporated into “standard” air handlers.
Packaged, Central, and Custom Air Handlers

ARI Standard 430 defines central station air-handling units as “... a factory-made encased assembly consisting of a fan or fans and other necessary equipment to perform one or more of the functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying and mixing of air; and shall not contain a source of cooling or heating other than gas or electric heat. This device is capable of use with ductwork having a total static resistance of at least 0.5 in. wg.”

Although the term “fan coil” is frequently used interchangeably with air handler, ARI defines fan coils as being “non-ducted,” or applied to systems operating with less than 0.25 inch static resistance.

In the commercial HVAC market, air handlers range from simple “packaged” air handlers up to approximately 15,000 cubic feet per minute (cfm) range, to large central station air handlers capable of delivering over 100,000 cfm. Let’s take a moment to look at the differences between them.

Packaged Air Handlers

Packaged air handlers have a fixed fan and coil configuration. They are typically used for low pressure comfort cooling and heating applications that require less than two inches external static pressure. Packaged air handlers have a more limited set of options than central station air handlers, generally composed of heating coils, mixing boxes, and discharge plenums.

Most often, they are matched to split system condensing units and heat pumps, although optional chilled water coils may be available. Several manufacturers provide matched performance ratings with their condensing units and certify these ratings under ARI Standard 340/360 (Unitary Large Equipment). As a result, packaged air handlers are usually classified by nominal cooling tonnage, rather than airflow.
Central Station Air Handlers

In contrast, central station air handlers, sometimes referred to as “applied” or “built-up” air handlers, offer a wide range of component options to cover an almost limitless set of application needs, both commercial and industrial. Central station air handlers range in size from 1,500 cfm for small single-zone applications, to large, fully custom air handlers capable of delivering over 100,000 cfm to constant volume or variable air volume systems. Although the size range is large, the majority of comfort air-conditioning applications fall into the 1,500 to 50,000 cfm size range.

To simplify the design process and keep the time required to design, build, and deliver the air handler to a minimum, most manufacturers offer a “standard” catalog offering of pre-engineered sizes and components. These components are assembled by the designer in building-block fashion to suit the job requirements. In addition to traditional catalogs, some manufacturers offer computer selection software that facilitates the configuration and selection of a unit, along with detailed engineering drawings and data for submittal and ordering purposes.

Custom Air Handlers

Custom air handlers are used where standard unit designs cannot easily be applied. Typical volumetric flow rates for custom air-handling equipment range from 50,000 cfm to 300,000 cfm or greater. However, custom equipment can also be found on a much smaller scale where space restrictions, strict sound requirements, low leakage rates or special materials and construction methods are required. These units are designed to meet the exact requirements of a given project and can include a staggering array of options and accessories.
Custom air-handling equipment design is driven by the requirements of the application. When size restrictions are a major concern, the most efficient component selections are made to fit in the minimum available space. If sound is a primary concern, appropriate materials and components are selected and arranged within the cabinet to minimize the sound output power levels radiated through the cabinet, at the inlet and at the outlet of the unit.

Selection Basis for Central Station and Custom Air Handlers

The cataloged size of an air-handling unit often refers to the face area in square feet of the largest cooling coil that can be installed in that particular casing. Once the required airflow rate is established from the building load estimate and design requirements, the engineer will define a maximum permissible cooling coil face velocity. The maximum design air velocity is limited to prevent condensate on the coil surface from being blown off the coil surface and into downstream components. Coil velocity limits vary with coil fin material and coil design. Typical design air velocities for aluminum-finned coils are generally in the 500-550 feet per minute (fpm) range. For example, an application requiring 25,000 cfm operating at 500 fpm would require an air handler with a 50-square foot coil. This would then equate to a nominal size 50 air handler. Note that for a particular nominal size, actual coil face area can vary slightly between manufacturers, as they are generally rounded to a nominal unit size. Heating coils do not condense moisture, therefore do not exhibit moisture blowoff. Face velocities can be higher (900 fpm) and are limited by airside pressure drop.

Without employing any energy recovery or gas-fired heating options, a custom air-handling unit is similar to a standard air handler in that it is typically designed around the total face area of the cooling coil required to meet minimum performance requirements. That is, the cooling coil dimensions are based on the maximum allowable face velocity, which varies with respect to coil duty and the tube and fin material options prescribed by the application.

Custom air handlers provide precisely engineered solutions with a wide variety of heating, cooling, humidification, filtration and energy recovery options on a job-by-job basis.

<table>
<thead>
<tr>
<th>Coil Moisture Blow-off Limits (fpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fins per inch</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>14</td>
</tr>
</tbody>
</table>

1. Limits apply to clean and properly maintained coils.
2. The limits shown are for Carrier 39 Series coils. Consult manufacturer for specific data.

The relationship between airflow volume (cfm), velocity (V) and area (A) is:

\[ \text{cfm} = VA \quad \text{or} \quad A = \text{cfm}/V \]

Where:

- \( A = H \times L \)

Solution:

- \( A = \text{cfm} / V \)
- \( A = 25,000 \; \text{cfm} / 500 \; \text{fpm} \)
- \( A = 50 \; \text{ft}^2 \) cooling coil required (nominal size 50 unit would be selected)