Capacity Analysis

Introduction

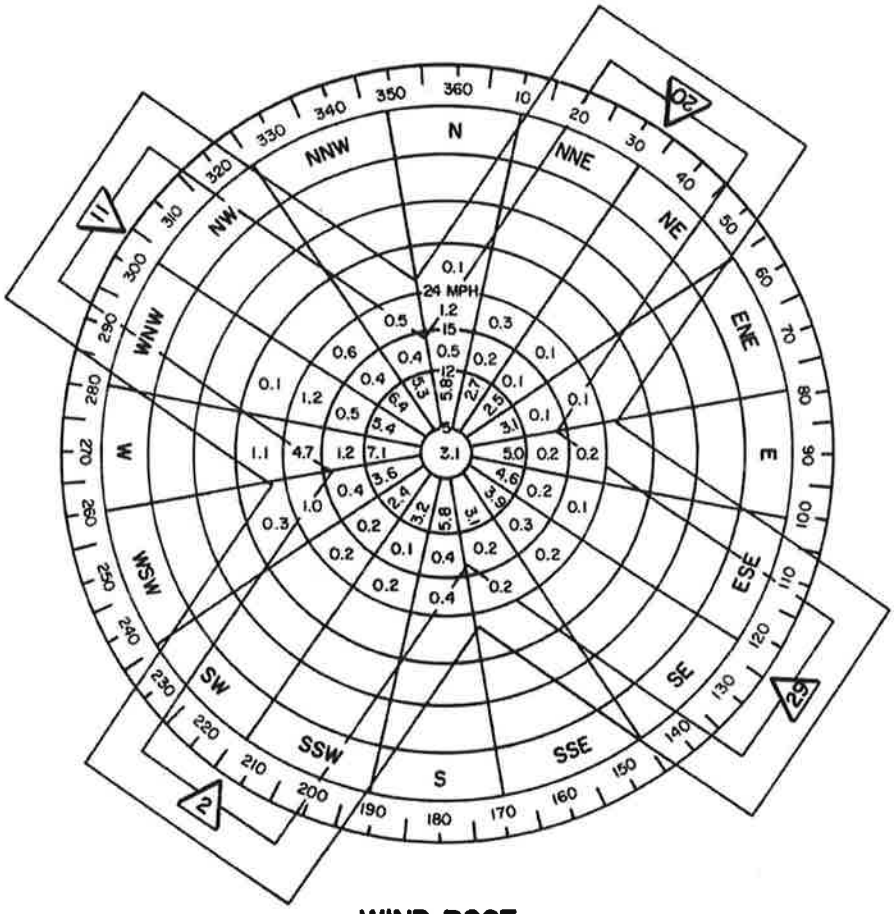
The capacity analysis for Jefferson County Airport is composed of two distinct, yet very related, elements: airfield capacity and landside capacity. The capacity of an airfield is primarily a function of the major aircraft traffic surfaces that compose the facility and the configuration of those surfaces (runways and taxiways), but it is also related to and considered in conjunction with wind coverage, airspace utilization, and the availability and type of navigational aids. Landside capacity is used to determine what improvements are needed regarding terminal building space, FBO areas, hangars, apron space, special use areas, access roadways and automobile parking. Capacity refers to the "number" of aircraft or operations that a facility can accommodate, either on an hourly or yearly basis, and does not refer to the "size" or "weight" of the aircraft.

Airfield Capacity

This section deals with the capability of the airside facilities, runways and taxiways, to accommodate the existing and projected demand at the airport. The capacity of an airport's airside facilities are a function of correct runway orientation to provide adequate wind coverage, and the actual physical size and layout of these facilities. These items are discussed below.

Wind Coverage. Surface wind conditions have a direct effect on the operation of an airport; runways not oriented to take the fullest advantage of prevailing winds will restrict the capacity of the airport to varying degrees. To determine wind velocity and direction at Jefferson County Airport, wind data were obtained and an all-weather wind rose was constructed. The wind data was obtained for the period 1971-1975 and was local to the airport.

For utility type aircraft, a 12-MPH crosswind component is considered maximum, although larger type aircraft can safely operate with a 15-MPH crosswind component. The desirable wind coverage for an airport is ninety-five percent (95%). This means that runway orientation and configuration should be developed so that the maximum crosswind component for utility or transport category aircraft



WIND ROSE

SOURCE: U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
STATION NO. 93068 BROOMFIELD, COLORADO
PERIOD OF RECORD: 1971 – 1975 (16-20 OBS./DAY)
WIND COVERAGE: (12 MPH): 11/29: (92.1%)
(12 MPH): 2/20: (88.5%)
(12 MPH): ALL: (95.3%)
(15 MPH): 11/29: (96.2%)
(15 MPH): 2/20: (93.5%)
(15 MPH): ALL: (98.2%)

Figure 5 ***Wind Rose***

is not exceeded more than five percent (5%) of the time. Based on the wind analysis for Jefferson County Airport, Runways 11/29 have 96.2% wind coverage for the 15-MPH crosswind component and approximately 92.1% wind coverage for the 12-MPH crosswind component. Runway 2/20 has 88.5% wind coverage for the 12-MPH crosswind component and 95.3% wind coverage for the 15-MPH crosswind component. Together the two runways provide approximately 95.3% wind coverage for the 12-MPH crosswind component and 98.2% for the 15-MPH crosswind component. This analysis indicates that the existing runway configuration provides adequate wind coverage for the existing and forecasted type of aircraft that use or will use the airport. Annual operations occur to the northwest approximately sixty percent (60%) of the time, and occur to the southeast approximately thirty-eight percent (38%) of the time, with the remaining two percent (2%) being to the north. Visual flight rules (VFR, ceiling greater than or equal to 1,000 feet and visibility greater than or equal to three miles) conditions occur approximately ninety-one percent (90.8%) of the time and instrument flight rules (IFR, ceiling less than 1,000 feet but greater than or equal to 200 feet and visibility less than three miles but greater than or equal to one-half mile) occur approximately seven percent (7.2%) of the time, with the remaining time the airport being below minimums for ILS approaches. The Runway 29R RNAV approach has a minimum ceiling of five hundred feet and minimum visibility of one-half mile. The wind analysis indicates that the existing runway configuration at Jefferson County Airport provides more than adequate wind coverage for the type of aircraft that both presently and in the future will utilize the airport, and no additional runways are needed from a *wind coverage* standpoint.

Capacity Analysis. The methodology presented here provides for the determination of airport capacity based on the type and mix of aircraft utilizing the airport, runway configuration, taxiway exits and configuration, and wind rose analysis.

The Annual Service Volume (ASV) of an airport is a reasonable estimate of an airport's annual capacity. It accounts for differences in runway use, aircraft mix, weather conditions, etc., that would be encountered over a year's time. Capacity is a measure of the maximum number of aircraft operations which can be accommodated on the airport in an hour, and is referred to in terms of both VFR and IFR capacity. The assumptions (as dictated by the Advisory Circular) utilized to determine both ASV and capacity are as follows: arrivals equal departures; the percent of touch-and-go is between zero and fifty percent of total operations; there is a full-length parallel taxiway with ample exits and no taxiway crossing problems; there are no airspace limitations; the airport has at least one runway equipped with an ILS and has the necessary ATC facilities and services to carry out operations in a radar environment; IFR weather conditions occur roughly ten percent of the time; and approximately eighty percent of the time the airport is operated with the runway-use configuration which produces the greatest hourly capacity. Based on a methodology to determine the above factors for long-range planning purposes for

airports, the ASV for Jefferson County Airport has been determined to be approximately 355,000 operations, with a VFR capacity of approximately one hundred ninety-seven (197) operations per hour and an IFR capacity of approximately fifty-nine (59) operations per hour. It is recognized that Jefferson County Airport does not conform to all of the assumptions stated above (full parallel taxiway on Runways 11/29 and airspace constraints), which results in a loss of capacity from the figures presented above, and it is anticipated that the actual IFR hourly capacity is closer to forty-four (44) operations per hour, the VFR hourly capacity is closer to one hundred and forty-seven (147) operations per hour and the ASV is also most likely reduced to some 266,250. As can be seen, the airports Annual Service Volume, under unconstrained conditions, is greater than the number of operations forecasted for the end of the planning period, although additional taxiways and the upgrading of Runway 11L/29R will be required to eliminate the *on airport* constraints to the ASV. The full ASV cannot be achieved until the airspace conflicts (as described below and previously) are resolved, which is beyond the capability of the airport to accomplish. In addition, it is recommended that when sixty percent (60%) of the ASV is reached (159,750 operations), then an airport should start planning ways to increase that capacity and when eighty percent (80%) of ASV is reached (213,000 operations) then construction of facilities to increase capacity should be initiated. These conditions should be monitored as trends and not just as one-time occurrences, although adequate lead time is important to provide adequate facilities when actually needed but at the same time staying within budgetary constraints. As can be seen, the airport has historically exceeded the sixty percent level (from 1973 through 1981, generally and in 1984) and this Airport Master Plan is very timely. In addition, the airport has exceeded the eighty percent level (1974 through 1977) and is forecasted to do so again before the end of the planning period. In addition, the constrained ASV will be exceeded by the end of the planning period, although the *unconstrained* ASV will not be exceeded. This analysis indicates that ASV will become a problem within the planning period and must be addressed so that construction of the needed facilities can commence at the proper time.

Another factor restricting capacity, especially during IFR conditions is the airspace congestion and arrival procedures occurring in the Denver metropolitan area, with Denver Center and Denver Tower. The airspace congestion and routing procedures place Jefferson County at a disadvantage, due to the fact that arrivals from the southeast to the ILS on Runway 29R cross the north/south runways at Stapleton. As stated earlier, this situation is being resolved (see discussion on page 19).

In addition to its operational characteristics, an airport's capability to accommodate the demand placed upon it is also a function of its physical characteristics. Physical characteristics consist of runway length, width and strength, among other things. Runway requirements will be discussed in a subsequent section.

Landside Facilities. Landside facilities include the terminal building, fixed base operation (FBO) areas, aircraft parking areas, access and perimeter roads, and other aviation oriented facilities. Upon analysis of these facilities, current deficiencies can be noted in terms of meeting future demands.

Aircraft storage facilities are somewhat lacking, even though there has recently been an increase in the number of hangars available due to the introduction of fifty eight (58) new Port-A-Port hangars. There is still a demand for additional hangar space, although it is very closely tied to the cost of leasing the facility and is dictated by economics. Aircraft tie-down space is also somewhat lacking and additional space needs to be provided. There are approximately three hundred forty-four (344) tie-downs on the airport, and according to Airport Management, there are sixty (60) tie-down spaces currently available for rent on the airport. This translates into only seventeen (17) percent of all tie-downs being available.

Internal and perimeter roadway location and alignment are in need of evaluation and adjustment, along with the placement of additional landside facilities. In addition, drainage problems need to be addressed, especially as to the impact it will have on future landside and airside facilities.

Facility Requirements

This section deals with the actual physical facilities and/or improvements to existing facilities needed to safely and efficiently accommodate the projected demand upon the airport. The section consists of two separate analyses: those requirements dealing with airside facilities and those dealing with landside facilities.

Airside Facilities. The types of aircraft projected to use Jefferson County Airport are important in order to plan future airport facilities. Knowledge of future aircraft utilizing the airport provides information concerning dimensional requirements; runway length; and runway, taxiway, and apron strength. The requirements relate to the "Design Aircraft" which is projected to utilize the airport. At Jefferson County Airport, it has been determined that the Gulfstream III aircraft is the "Design Aircraft". It has an approach speed of 136 knots and a wingspan of 78 feet. The aircraft presently operates out of the airport on a regular basis (two operations per week), and is expected to continue to do so in the future. In addition, another G-III has initiated use of the airport, on a regular basis, since completion of the runway extension. Jefferson County Airport is a Transport Airport, defined as "an airport that accommodates aircraft with approach speeds of 121 knots or more". The Gulfstream III is such an aircraft and is contained within Transport Airport Airplane Design Group II, which dictates certain design parameters and criteria. The Gulfstream III is the Design Aircraft for dimensional criteria only (building restriction line setback, runway/taxiway separation, aircraft

parking separation, etc.), and is *not intended* to be used to dictate *runway length* requirements.

Generally, runway length requirements for design purposes are premised upon the type of aircraft category utilizing an airport. The runway types that are associated with most general aviation aircraft include Basic Utility (BU), General Utility (GU), and Transport (T). The single engine piston aircraft all require the basic utility type runway. Most of the multi-engine piston aircraft require the basic utility type runway, although some do require general utility type runways. All of the turboprops require general utility type runways, and the turbojets generally require transport type runways.

As can be seen from the following table, entitled *RUNWAY LENGTH REQUIREMENTS*, there are four runway lengths shown for utility type runways. Each of these provides the proper length to accommodate the type of aircraft that will utilize the runway. Basic utility runways, both Stage I and II, range in length from 5,000 to 7,000 feet. The general utility runway length is shown to be 7,150 feet in length.

There are four different lengths given for the Transport (T) type runway included in the following table. All runway lengths are based on an elevation of 5,700 feet AMSL, 88 degrees Fahrenheit NMT (Mean Normal Maximum Temperature) and pertain to those aircraft, generally turbojet-powered, of 60,000 pounds or less maximum certificated takeoff weight. Each of these lengths provides a runway sufficient to satisfy the operational requirements of a certain percentage of the transport fleet at a certain percentage of the useful load, (i.e., 75 percent of the fleet at 60 percent useful load). The useful load of an aircraft is defined as the difference between the maximum allowable structural gross weight and the operating weight empty. In other words, it is the load that can be carried by the aircraft composed of passengers, fuel and cargo. The requirements of the transport aircraft range from 7,400 feet to greater than 13,000 feet in length for Jefferson County Airport, considering an effective runway gradient (ERG) of 1.0%. Generally speaking, the following aircraft comprise seventy-five percent of the transport fleet: Learjets, Sabreliners, Citations, Fan Jet Falcons, HS-125 and the Westwind.

Table 13
RUNWAY LENGTH REQUIREMENTS
Jefferson County Airport Master Plan

Runway Category	Length (Feet)	With ERG 1.0%
Basic Utility Stage I	5,000	5,300
Basic Utility Stage II	7,000	7,700
General Utility	7,150	7,900
Transport 75/60	6,850	7,400
Transport 100/60	11,000+	13,000+
Transport 75/90	8,600+	9,600+
Transport 100/90	11,000+	13,000+

As presented earlier, the Gulfstream III currently operates regularly at the airport and has been selected as the design aircraft. In addition, two (2) Lockheed Jetstar aircraft are based at the airport. The Gulfstream III and the Jetstar represent the critical aircraft for determining runway length which either currently operate at the airport or are expected to operate at the airport in the future. The foregoing table presented general data concerning runway length requirements; however, for more detailed planning and design, the actual requirements of the aircraft currently using the airport are considered to be more reflective of the actual situation and needs, and, therefore, will be used to supplement the standardized data found in Table 12. The purpose here is to establish a program for development which is realistic, practical and specifically oriented to the needs presented at Jefferson County Airport.

Utilizing the operation manuals for both the Gulfstream III and the Jetstar, along with interviews of the operators of these aircraft, the determination was made that the Jetstar was the more critical aircraft concerning runway length at Jefferson County Airport. The Jetstar can operate at the design temperature and altitude with a 1% effective runway gradient without severe takeoff weight restrictions on the 9,000 feet of runway length provided by Runway 11L/29R. **Therefore, runway extensions beyond 9,000 feet are not being recommended.**

An important factor to remember when considering runway length requirements is that the actual length necessary for a runway is a function of elevation, temperature and aircraft stage length. As temperatures change on a daily basis, the runway length requirements change accordingly. The cooler the temperature, the shorter the runway necessary; therefore, because an airport is designed to accommodate 75 percent of the fleet at 90 percent useful load, this does not mean that at certain times a larger business jet cannot use the airport or that aircraft cannot use it with heavier loadings than 90 percent.

In addition to runway length requirements, airport design criteria is also a determining factor in providing for future airport expansion and development. The design criteria for an airport is dependent upon the design aircraft dimensions, the type of or lack of instrumentation available or programmed at the airport and the type of aircraft projected to use the airport. The design criteria shown in the following table are those required for Transport Airport Airplane Design Group II, along with the existing dimension for the corresponding facility.

Table 14
DIMENSIONAL STANDARDS FOR TRANSPORT DESIGN GROUP II (In feet)
Jefferson County Airport Master Plan

Item	Dimension	Existing Dimension
R/W Width	100	100
R/W Safety Area Width	500	Not Designated
R/W Safety Area Length	1,000	Not Designated
T/W Width	35	50
R/W CL T/W	400	250
R/W CL R/W	700 to 4,300	1,125
R/W to BRL	750	750-
R/W to AC parking	500+	Not Designated

Landside Facilities. The number and type of projected operations and based aircraft can be converted into projected landside facilities. In general, the accompanying table shows the type of facilities and the number of units or acres needed for that facility in order to meet the potential demand for each development phase. As can be seen, by the year 2007, a total of 94.7 acres will be required for landside facilities. As discussed in the capacity analysis section, the major landside facilities needs are in the form of aircraft storage. The demand for executive hangars, T-hangars and apron space will certainly increase during the planning period, with demand presently being exhibited for T-hangars and apron space. As shown in the accompanying table, fifty (50) acres will be needed for hangar development, both T-hangars and executive hangars. This translates into four hundred eighty (480) T-hangars and sixteen (16) executive hangars. Apron storage will account for approximately forty-three (43) acres and the remaining acreage will be devoted to terminal building and fire-rescue facility expansion. This total does not include needed auto parking expansion. Access and perimeter roadway locations and land requirements are not included in this tabulation because the amount of land necessary for these facilities will be a function of the location of the other facilities as well as the most effective routing of these roadways. The table depicts the area

required for landside facilities during all stages of development. This will assist in the development of detailed facility staging discussed in a latter section of the document.

Table 15
LANDSIDE FACILITY REQUIREMENTS
Jefferson County Airport Master Plan

Facility	1992	1997	2002	2005
Itinerant Apron	14.0	15.0	16.0	18.0
Based Aircraft Apron	14.9	18.4	22.2	25.4
Hangars				
T-Hangars (no/acres)	380/30.4	410/32.8	450/36.0	480/38.4
Executive (no/acres)	8/6.0	10/7.5	12/9.0	16/12.0
Terminal Building	.2	.2	.5	.5
Fire-Rescue	.2	.2	.2	.4
TOTAL ACRES	65.7	74.1	83.9	94.7