Evaluation of a Technique to Simplify Area Navigation and Required Navigation Performance Charts

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13. ABSTRACT (Maximum 200 words)

Performance based navigation (PBN), an enabler for the Federal Aviation Administration’s Next Generation Air Transportation System (NextGen), supports the design of more precise flight procedures. However, these new procedures can be visually complex, which may impact the usability of charts that depict the procedures. This study evaluated whether there are performance benefits from simplifying aeronautical charts by separating visually complex area navigation (RNAV) and required navigation performance (RNP) procedures onto different chart images. Forty-seven professional pilots who were qualified to operate with RNAV and RNP participated. They used high-fidelity current and modified charts to find specific information from RNAV (RNP) approach and RNAV Standard Instrument Departure (SID) chart images that were shown one at a time on a computer monitor. Response time and accuracy were recorded.

Results showed a consistent and significant reduction in the time to find information from the simplified chart images. Response time varied linearly with a simple clutter metric, the sum of visual elements in the depiction, indicating serial visual search. Most questions were answered with high accuracy, but some questions about altitude constraints yielded low accuracies. This experiment did not explore practical disadvantages of separating paths, such as the increased number of images to handle.

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Preface and Acknowledgements

The study described in this report was designed as a collaborative effort between the United States Department of Transportation (USDOT) John A. Volpe National Transportation Systems Center (Volpe Center) and the Massachusetts Institute of Technology (MIT). Ms. Abhizna Butchibabu performed this study as part of her work towards a Master's degree under Professor R. John Hansman in the MIT Department of Aeronautics and Astronautics. The MIT report (Butchibabu and Hansman, 2012) was produced under Volpe Center Contract No. DTR57-07-D-30006.

This final government report was prepared independently by Volpe Center. It is the authoritative record of this study. This document provides comprehensive analysis and discussion, updating and expanding upon earlier reports.

The Federal Aviation Administration NextGen Human Factors Division (ANG-C1) coordinated the research requirement, and its principal representative acquired, funded, and technically managed execution of the research services described in this report. We thank Tom McCloy and Dan Herschler, the Program Managers for this research. We also thank Kathy Abbott (AVS) and Mark Steinbicker (AFS-470), FAA sponsors for this work, for their input.

The modified chart prototypes tested in this experiment were created by FAA Aeronautical Navigation Products (AeroNav Products) and Jeppesen, Inc. Thanks go to John Moore, Valerie Watson, and Alex Rushton from FAA AeroNav Products and Ted Thompson and Jeff Williams from Jeppesen.

Thanks also to Volpe Center staff members Andrew Kendra, Maura Lohrenz, and Alan Yost, and Alan Midkiff of MIT for their review of this report and assistance with the experiment, and to Michael Zuschlag (Volpe Center) for his invaluable assistance with the data analysis.

Thanks also to all the pilots who participated in the study and to the Airline Pilots Association (ALPA) and the National Business Aviation Association (NBAA) for their help recruiting participants for the study.

Feedback on this document may be sent to Divya Chandra (Divya.Chandra@dot.gov) or Rebecca Grayhem (Rebecca.Grayhem@dot.gov). Further information on the Instrument Procedures research program is available at http://www.volpe.dot.gov.

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
oz	ounces	28.35	grams	g
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
mL	milliliters	0.034	fluid ounces	fl oz
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
g	grams	0.035	ounces	oz
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	Kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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Executive Summary

This study is part of a comprehensive research program led by the USDOT Volpe Center regarding human factors issues related to the introduction of instrument procedures that rely upon area navigation (RNAV) and required navigation performance (RNP). These technologies are the foundation for performance-based navigation (PBN), which is a key enabler for the Next Generation Air Transportation System (NextGen) being developed in the United States (US) by the Federal Aviation Administration (FAA). The FAA is transitioning to PBN to increase the safety and efficiency of flight operations.

One of the concerns with RNAV and RNP operations is that the design, depiction, and implementation of these new procedures can result in paths that are complex to fly, with precise speed, altitude, and lateral path constraints. The study described in this report examines the usability of visually complex chart images for RNAV and RNP procedures, specifically, for RNAV approaches with RNP segments and RNAV Standard Instrument Departures (SIDs). The experiment was conducted to determine whether chart images showing fewer paths ("modified" charts) allow improved access to information in terms of time and accuracy compared with chart images that are currently used, which show all paths on one chart ("current" charts). Our hypothesis was that it would be faster to find information from charts with fewer paths depicted on each image.

Response time and accuracy data on an information-search task were obtained from 47 active professional pilots (airline and corporate) qualified to fly RNAV and RNP operations. Six airport procedures were tested, three approaches and three SIDS. High fidelity modified chart images were produced with assistance from FAA Aeronautical Navigation Products and Jeppesen, Inc. Fourteen pilots were assigned to use the FAA charts and 33 used the Jeppesen charts for the test.

Response times were significantly reduced with the modified charts. For approach charts, pilots saved just over 6 seconds on average using the modified (simpler) chart images (16.9 seconds versus 10.7 seconds). They saved 3 seconds on average with the modified SID chart images (16.2 seconds versus 13.3 seconds). This pattern of improvement was consistent across different types of pilots, different airport procedures, and charting conventions.

We found that the time to find specific information from the chart could be modeled as a linear function of a simple clutter metric, the sum of visual elements in the plan view of an approach chart or the sum or graphical route elements on a SID. This model indicates serial visual search for the data of interest, a common strategy. We expect that results of the study are generalizable to other types of aeronautical charts and pilots because of the visual search strategy that we found.

Pilot responses were generally accurate, although there were some altitude constraint questions that yielded low accuracies. This issue may warrant further study.

This study did not address practical considerations related to the implementation of the modification technique that was tested. For example, we did not develop criteria for determining when an instrument procedure is sufficiently complex to justify depicting it across multiple chart images instead of just one. Our clutter metric did not show a threshold level at which search times suddenly increase, so it does not specify a criterion for deciding whether a procedure should or should not be separated across chart images. We also did not examine the impacts of this modification technique on other chart-related pilot tasks (e.g., route planning and review). Finally, we did not address the challenges that may arise from handling more chart images, such as establishing a naming convention for the different images and understanding the time needed to manage and search across the chart images. Future research efforts may address these practical considerations as resources permit.

Abbreviations and Acronyms

ATC	Air Traffic Control
BOI	Boise, Idaho
BZN	Bozeman, Montana
DC	District of Columbia
DFW	Dallas-Fort Worth, Texas
FAA	Federal Aviation Administration
FMS	Flight Management System
IAF	Initial Approach Fix
IAP	Instrument Approach Procedure
IF	Intermediate Fix
ILS	Instrument Landing System
LAS	Las Vegas, Nevada
LAX	Los Angeles, California
MEA	Minimum Enroute Altitude
NextGen	Next Generation
PBN	Performance Based Navigation
PDK	Peachtree DeKalb, Georgia
PSP	Palm Springs, California
RNAV	Area Navigation
RNP	Required Navigation Performance
RWY	Runway
SID	Standard Instrument Departure
SLC	Salt Lake City, Utah
US	United States

1 Background

Area navigation (RNAV) and required navigation performance (RNP) are key enablers for performance-based navigation (PBN) operations. As such, they are also important for a successful transition to the Federal Aviation Administration (FAA) Next Generation Air Transportation System (NextGen). RNAV procedures allow an aircraft to fly directly between points in space without relying on conventional ground-based navigation aids (e.g., by using satellite-based navigation). Required navigation performance (RNP) is a refinement of RNAV that includes on-board monitoring and alerting to ensure that the actual performance of the navigation system keeps the aircraft position within established criteria. RNP allows more precise path design, which can be particularly useful for developing approach procedures to runways. Instrument procedures based on RNAV and RNP offer safety enhancements along with new levels of flexibility to negotiate terrain, airspace, and environmental considerations. We use the term RNAV (RNP) to refer to procedures that have RNP segments.

RNAV and RNAV (RNP) procedures bring challenges for human performance because the flight paths must be flown more precisely. There are more altitude and speed constraints for the pilot to manage and more notes for the pilot to interpret. Pilots are specially trained to perform these procedures with the aid of various levels and types of flight deck automation. They must be able to understand the flight path, determine equipage requirements, understand RNAV and RNP terminology used by Air Traffic Control, and understand how to interpret flight deck automation and alerting interfaces properly for these procedures (FAA 2007, 2009, and 2011). Chandra and Grayhem (2012) describe a variety of human factors research issues that arise with PBN.

A technical report on RNAV and RNAV (RNP) procedures and their depiction provides more detailed background on human factors issues related to procedure design and depiction (Chandra, Grayhem, and Butchibabu, 2012). Chart manufacturers use a variety of graphical techniques to reduce confusion on charts, which are *depictions* of the procedure. For example, shading, bolding, font size, and paper size can be adjusted to improve the readability of charts. Sometimes, however, these graphical techniques may not be sufficient, and the procedure design itself (the routing instructions) may need to be reconsidered.

Chandra, et al. (2012), also presents an analysis where we identified objective parameters of procedures that were related to the difficulty of use. One factor that was significant for both Standard Instrument Departures (SIDs) and approaches is the depiction of more flight paths on an image. This situation occurs on an RNAV (RNP) approach when there are multiple Initial Approach Fixes (IAFs) and multiple Intermediate Fixes (IFs) that define alternate paths to the runway. On RNAV SID charts, multiple paths occur when there are multiple transition routes to the en route airspace and/or when there are multiple runways, each with their own transition to a common segment. Multiple paths were not associated with increased difficulty of use for Standard Terminal Arrival Routes (STARs). For STARs, having more path segments (waypoints) and more altitude constraints were the key factors.

Because RNAV and RNAV (RNP) allow more path design flexibility, there is inevitably more variation in how the route looks as well. Procedures that show multiple paths can be visually complex, which may increase the time pilots need to scan the chart image for necessary information. Therefore, one consequence of the flexibility offered by RNP is that it may take more time and effort to read and review those charts to fully understand the procedure. Figure 1 and Figure 2 illustrate this point.

Figure 1 shows the plan view of a conventional ground-based approach procedure. The image was extracted from the FAA chart for the Instrument Landing System (ILS) approach to Boise, Idaho Runway 10R. It has a simple straight approach path, represented by the arrowhead towards the runway.

There are different ways to join the final approach, as indicated by the thin lines from Emett, Salla, and Renol. This procedure is familiar to professional pilots and therefore easy to read; it looks like any other standard ILS procedure. The ILS can be flown with or without the help of flight deck automation.

Figure 2 shows a similar view of a corresponding RNAV (RNP) approach, which requires special aircraft and aircrew certification. This image was extracted from the FAA chart for the RNAV (RNP) Z approach to Boise, Idaho Runway 10R. In contrast to the ILS procedure, it has multiple approach paths, some of which include curved segments. There are also more path segments, more named points, and other information for each path. The scale of the plan view was adjusted to show a larger area, as seen by comparing the shaded areas of terrain in Figure 2 with those shown in Figure 1.

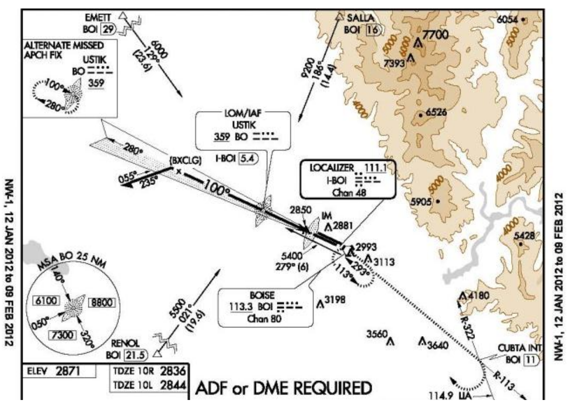

Figure 1. Plan view of an ILS approach at Boise.

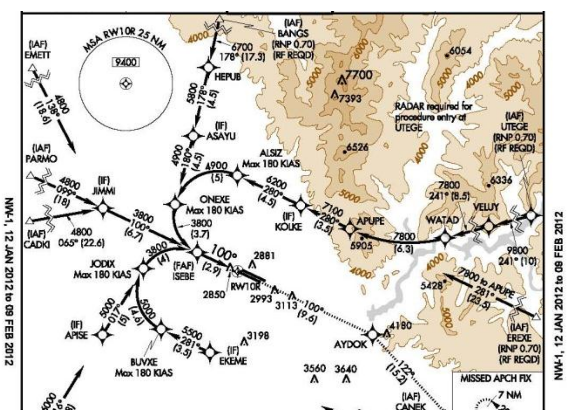

Figure 2. Plan view of an RNAV (RNP) approach at Boise.

2 Objectives and Scope

We examined a proposal to reduce the visual complexity of RNAV SID and RNAV (RNP) approach charts by addressing the issue of multiple paths. The technique is to separate paths across images in a logical manner. We hypothesized that it would be faster to retrieve information from “modified” charts, which show fewer paths, than from the original “current” charts, which show all the paths on one image.

The pilot’s task was to find specific information using a chart image that was shown on a computer monitor. To prepare for this task, pilots saw a text description of the planned route and the question about that route before they saw the chart. The chart image shown was always the correct one for the route description and question given. We recorded the time they spent viewing the chart and their response accuracy. The pilots were asked to answer question as quickly and as accurately possible.

To focus the experiment on finding performance benefits, only visually complex RNAV (RNP) approach and RNAV SID procedures were selected for the study based on subject matter expert input. RNAV arrival procedures were not selected for the study because we and our subject matter experts were not able to identify any especially visually complex RNAV STARs. This is in agreement with our earlier findings from the objective procedure complexity analysis, which showed that multiple flight paths were not an issue for STARs (Chandra, et al., 2012).

There are practical considerations to the modification technique of separating paths across chart images. For example, there would be more paper to carry in the flight deck (or more chart images to choose from in a database), a need for an industry-standardized revision to chart naming conventions, and potentially some time spent searching for the correct image within a set of separated images. Another potential consideration is that pilots may have to work harder to be aware of nearby paths that are not depicted on one chart image, but are available for use even though they are shown on a separate image. Modifications to charts may also affect their use by Air Traffic Controllers (ATC), e.g., for training purposes and/or sector assignments.

This experiment did not explore these practical considerations of separating paths onto different chart images. Instead, the study is just a first look to determine whether or not there is any performance benefit to separating paths onto different images. As resources permit, future research efforts may address these practical considerations.

3 Method

Butchibabu, Grayhem, Hansman, and Chandra, 2012 provides a detailed description of the method and an overview of the main results in a short conference paper. Portions of the Methods section in this report were reproduced from that paper. The study is also presented in a technical report (Butchibabu and Hansman, 2012) that covers this and related efforts that were also presented elsewhere (Butchibabu, Midkiff, Kendra, Hansman, & Chandra, 2010; Chandra et al., 2012). A more recent conference paper (Chandra and Grayhem, 2013) summarizes the additional independent analyses that are presented here.

3.1 Participants

Participants were current RNP-qualified (see FAA, 2009; FAA, 2011) professional pilots with corporate or airline flight experience in the US. We collected data from 19 corporate and 28 airline pilots.[1] Fifteen pilots in our sample were check airmen (i.e., instructor pilots). The corporate pilots had an average of 10,179 hours of flight experience and the airline pilots had an average of 12,056 hours of flight experience. All of the participants used Jeppesen charts regularly. Some also had previous experience with FAA charts.

All participants had received simulator training on RNAV procedures within the last 12 months. Table 1 describes pilots' level of experience with RNAV and RNAV (RNP) procedures during their most recent

[1] Seven pilots in this group were airline Initial Operating Experience (IOE) training instructors. Data for these pilots were analyzed separately at first, but did not differ statistically from the other pilots. For the purpose of this report, the airline-training instructors are categorized as airline pilots.

active month. Most participants reported being comfortable flying RNAV SIDs. On a scale of 1 to 5, 25 of the 47 pilots chose the highest comfort rating (5). Most pilots were also comfortable with RNAV (RNP) approaches; 34 of 48 rated comfort level as either a 4 or 5. Three pilots had never flown an RNAV (RNP) approach procedure in actual operations.

Table 2 lists the number of pilots who had experience flying at the airports tested in the study. This table shows that pilots had more experience with the RNAV SIDs than with the RNAV (RNP) approaches in general. This is not surprising because the airports with RNAV SIDs have many more flight operations overall than the smaller airports chosen for their RNAV (RNP) approach procedures.

Table 1. Participant familiarity with RNAV and RNAV (RNP) based on their last active month.

	Operational Experience	Self-reported Average Number of Procedures Flown in Most Recent Active Month
RNAV (RNP) Approaches	41 of 47 (87%)	2.4
RNAV SIDs	44 of 47 (94%)	3.1

Table 2. Participants with flight experience at the airports selected for the experiment.

	Airport	Corporate (N=19)	Airline (N=28)	Total (N=47)
RNAV (RNP) Approaches	Boise, Idaho	1	0	1
	Bozeman, Montana	0	0	0
	Palm Springs, California	2	13	15
RNAV SIDs	Dallas-Fort Worth, Texas	2	10	12
	Las Vegas, Nevada	15	7	22
	Salt Lake City, Utah	5	1	6

3.2 Procedure

Figure 3 shows a flow diagram of the experimental procedure. At the start of the experiment, each participant was introduced to the study and signed an informed consent form. Participants also completed a background questionnaire that recorded their familiarity with RNAV and RNAV (RNP) procedures and information about their flight experience. Butchibabu and Hansman (2012) includes a copy of the consent form and background questionnaire.

Participants read an instruction sheet prior to completing the information-retrieval task. The instructions asked pilots to respond to the question as quickly and accurately as possible.

Fourteen pilots were assigned to use FAA charts for the study and 33 used the Jeppesen charts. The pilots in the FAA-chart condition reviewed a short set of training slides that highlighted differences between the Jeppesen and FAA charting conventions (Appendix A).

Participants completed the information-retrieval task in two blocks with a rest period between blocks. One block was for approaches and the other block was for SIDs. The order of the two blocks was counterbalanced between subjects. An optional break was offered in the middle of each of the two blocks. Chart modification (current or modified) was a within-subjects variable (i.e., each participant saw both current and modified charts). Modified and current charts were presented in random order within the appropriate block.

The approach block contained six practice trials and 56 test trials, where each trial involved answering one question. The SID block contained six practice trials and 44 test trials. We excluded data from the practice trials from the analysis.

The study concluded with a short post-task questionnaire (see Butchibabu and Hansman, 2012). Participants spent approximately one hour on the experiment including instructions, breaks, and the questionnaire, plus 15 minutes on the FAA chart refresher training if needed.

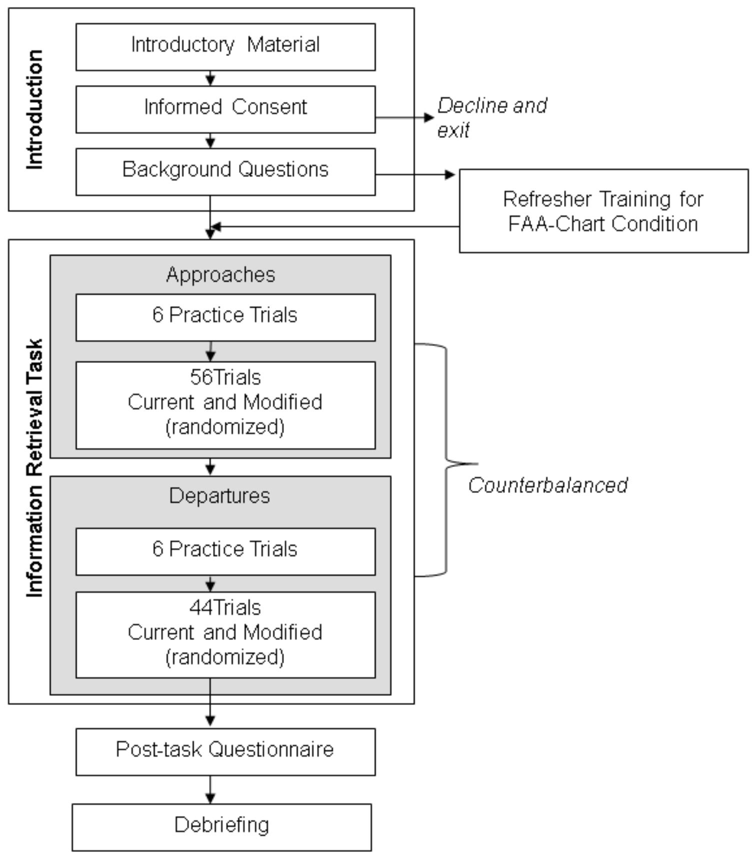

Figure 3. Flow diagram of the study.

3.3 Information Retrieval Task

Each trial in the task involved answering one question. Figure 4 shows a sample screen-shot from the experiment at the beginning of a trial. The pilot read a route description and an information retrieval question even before the chart was presented, to orient him or herself. The example route information in Figure 4 is "You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via PARMO." The example question associated with this route description is, "What is the maximum allowed speed at ELUMY?"

After reviewing the route description and question the participant clicked the "*Chart*" button to show the chart (Figure 5). At this point the software started a timer to track the amount of time participants spent looking at the chart. When the participant was ready to answer the question he or she clicked on the "*Answer Question*" button, which stopped the timer. At this point the chart was grayed out, preventing the pilot from reading the chart (see Figure 6). The pilot would then click on the "*Answer Question"* button a second time (to activate the text field) and type in their answer (180 knots in this example). If the pilot forgot the answer and wanted to view the chart again, he or she could click on the "*Chart*" button to call up the chart again; this action restarted the timer. Participants saw only the chart image that they needed to answer the question; they did not have to search for the correct chart image.

If the chart was composed of more than one image (e.g., if there was a second page of text notes, as with the FAA SIDs), the pilot had the option to toggle between the images using the appropriately labeled buttons on the lower right (as in Figure 7, *Graphical* and *Narrative/Notes*). The route description always matched the chart shown; there were no attempts to confuse the participant with a route description that did not match the chart image shown.

Cumulative time spent viewing the chart (across multiple viewings and chart images as needed) was recorded as the overall response time. Responses to questions were recorded and later scored manually for accuracy. There was no time limit on the trials.

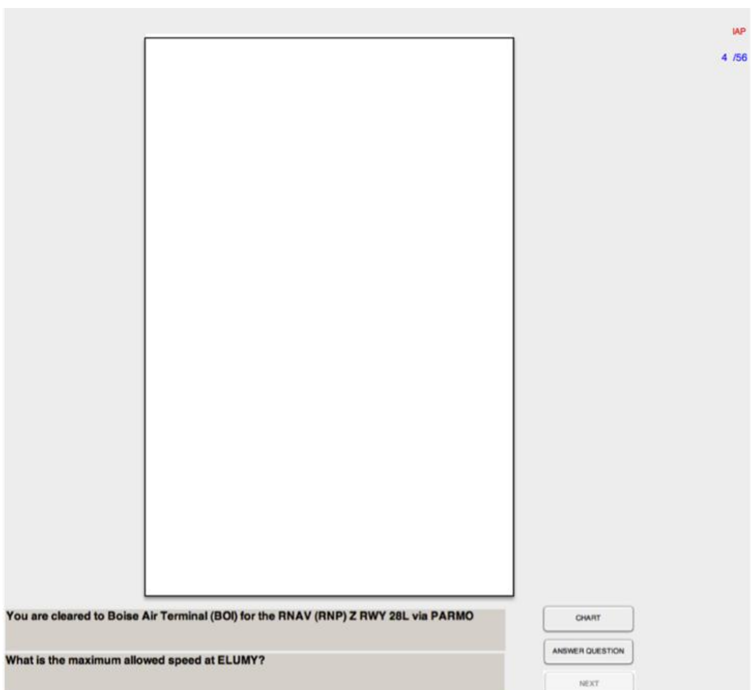

Figure 4. Display at the start of trial.

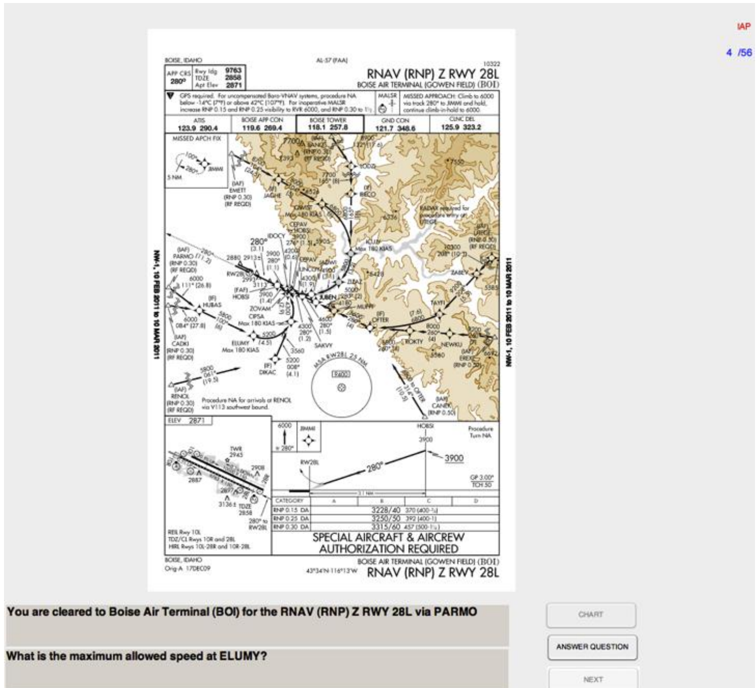

Figure 5. Display during information search using an approach chart.

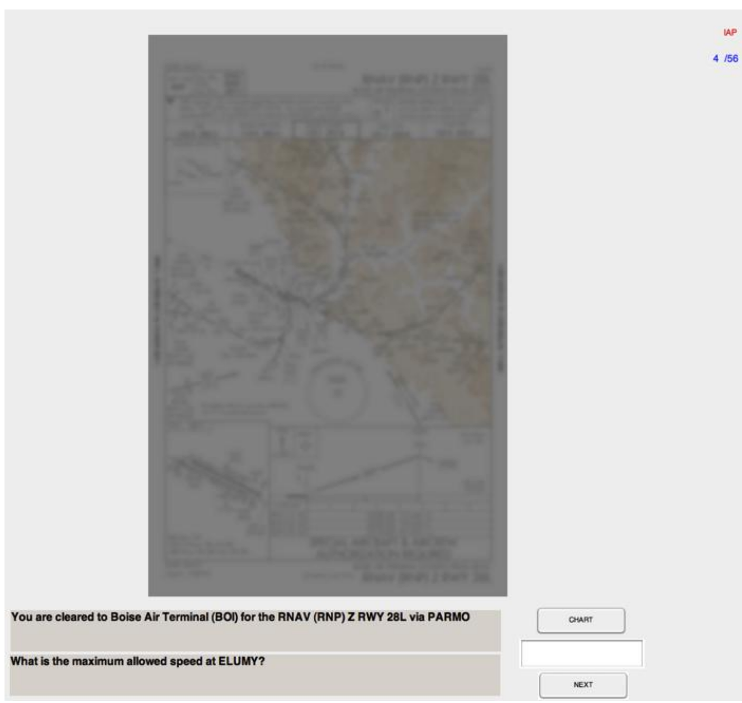

Figure 6. Display during response entry.

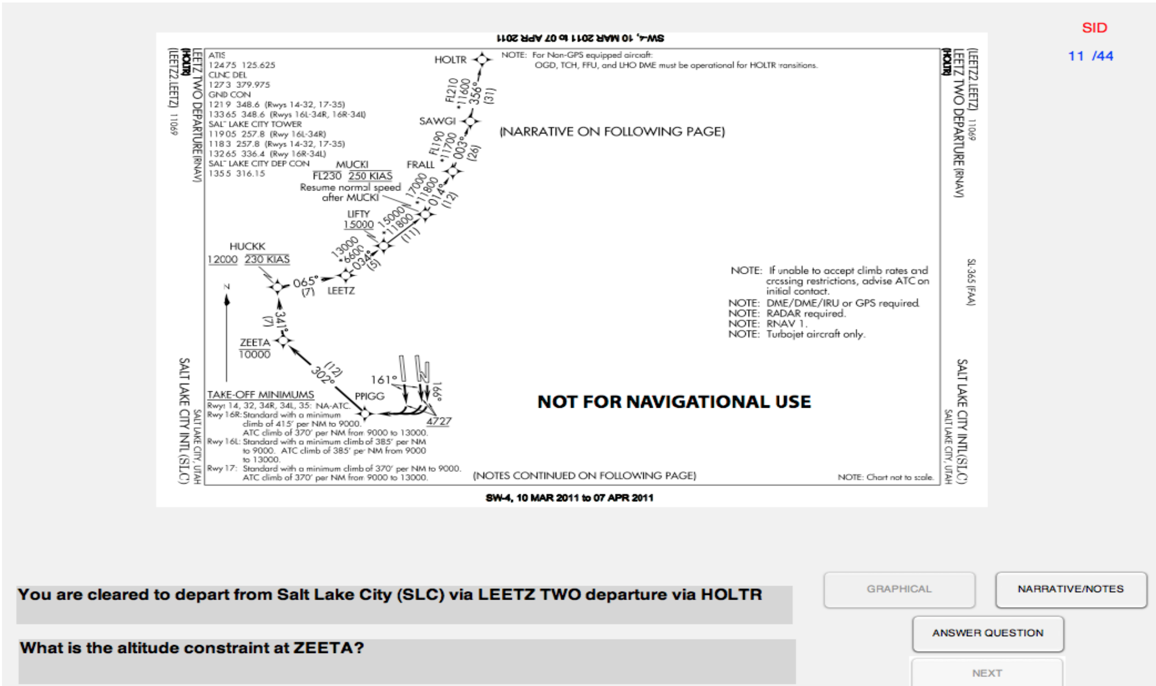

Figure 7. FAA SID chart trial with graphical and narrative pages.

3.4 Question Types

Different types of questions were posed during the experiment, asking for information such as speeds, altitudes, distances, frequencies, and headings. There was always an equal number of questions for the current and modified charts. However, the number of questions differed by airport because there were more questions when more paths were shown. For example, there were eight questions for each of the current and modified charts for Las Vegas, but only six questions for each of the Dallas chart images. Appendix B contains a list of all the questions for both the practice and experiment trials.

Question types were similar between the current and modified charts, but the specific questions for current charts were different from those for the modified charts so that each question was new to the pilot. If the same question were asked twice, it is possible that the pilot would remember the answer rather than use the chart to find the answer. As an example, a speed question on the current chart was matched with a different speed question on the modified chart.[2] Questions for FAA and Jeppesen charts were matched in all but four cases. These exceptions happened when the chart manufacturers depicted different information; for example, more communication frequencies are provided on FAA charts than Jeppesen charts. In these cases, different questions were asked between chart manufacturers.

The matched questions were not pre-tested to determine if they were similar in terms of difficulty.

[2] This was possible in all but one case, where a speed question was matched with a track question. Given that this was only one of more than 20 questions, we do not expect this inconsistency to have a significant effect on the findings.

3.5 Apparatus

The experiment software ran on a MacBook® laptop computer under the MATLAB® computing environment. The experiment display was a 22-inch external monitor with a resolution of 1680 pixels by 1050 pixels, approximately 90 pixels per inch. This monitor showed the chart in its original size along with other display information, such as the questions and buttons. Participants used a mouse and keyboard to enter their responses.

3.6 Chart Modifications

Current Jeppesen and FAA AeroNautical Navigation (AeroNav) Products charts were tested in the experiment as the baseline condition. The modified charts were created by Jeppesen and FAA using their respective charting conventions. Specifications for the multi-image format were determined in coordination with Jeppesen and FAA AeroNav Products. Details on the construction of the modified charts are provided below. Samples of the charts tested in the study are provided in Appendix C.

Six procedures, three RNAV (RNP) approaches and three RNAV SIDs, were modified into multi-image versions. Two additional procedures, one RNAV (RNP) approach and one RNAV SID, were used for the practice trials in their original (current) format.

All the approach and SID procedures selected for modifications were visually complex and contained multiple paths. Arrival procedures were excluded from the study because they were simpler and therefore not expected to benefit from this modification.

3.6.1 Path Selection

The experimenters, Jeppesen, and FAA AeroNav Products coordinated all aspects of the chart modifications, including selecting the procedures for the study, and which paths would be shown on the modified charts. To limit the number of images created, we did not create one image for every individual path on the original chart. Instead, paths with the most common segments were grouped. For approach procedures, paths that converged prior to the IF were grouped, allowing more information to be depicted on the profile views. For example, there are eight distinct paths into the Boise approach, but we created only four modified chart images (see Table 3).

We made minimal changes to the bulk of the remaining information on the graphic image. We removed notes that were irrelevant to the remaining path(s) and we extended arrows that were previously discontinuous when possible as a result of the deletion of some paths.

We modified text description pages for the FAA SID charts to match the modified graphic SID images by erasing the text information for paths that were not shown on the individual modified graphic images. There was a modified text page for each individual modified SID chart graphic image.

The modified graphic images were not zoomed or re-centered for optimal display of the remaining path(s). Table 3 lists the procedures that were tested, along with the number of images in the modified charts. Figure 8 and Figure 9 show a current and modified FAA approach chart, respectively.

3.6.2 Procedure Names

To distinguish individual images of the modified approach charts, IAF names were inserted at the top of each image below the original title. For SID procedures, the transition or runway names for each path were inserted at the top of the image below the original title. No other changes were made to the procedure titles. When there was more than one IAF (for approaches) or transition (for SIDs), the names were ordered alphabetically within the group. When there was more than one runway shown on a modified SID, the runways were listed in numerical order within the group.

For Jeppesen charts, images were numbered using their standard convention. Pages were ordered alphabetically based on the name of the first IAF or transition/runway on each image. Since these charts were never provided as a set, however, the Jeppesen numbering convention was not relevant for this study. It was included for consistency across current and modified charts.

3.6.3 Vertical Profile on Approach Procedures

For the approaches, the vertical profile was modified for each image to begin from the IF unless the common waypoint was after the IF.

Table 3. List of procedures tested.

Type	Airport	Code	Procedure Name	Images in Modified Set
Approaches	DeKalb Peachtree, Georgia (practice)	PDK	RNAV (RNP) Z RWY 20L	Not applicable
	Boise, Idaho	BOI	RNAV (RNP) Z RWY 28L	4
	Bozeman, Montana	BZN	RNAV (RNP) Z RWY 12	3
	Palm Springs, California	PSP	RNAV (RNP) Y RWY 31L	3
SIDs	Los Angeles, California (practice)	LAX	HOLTZ NINE	Not applicable
	Dallas-Fort Worth, Texas	DFW	DARTZ THREE	2
	Las Vegas, Nevada	LAS	SHEAD SEVEN	2
	Salt Lake City, Utah	SLC	LEETZ TWO	3

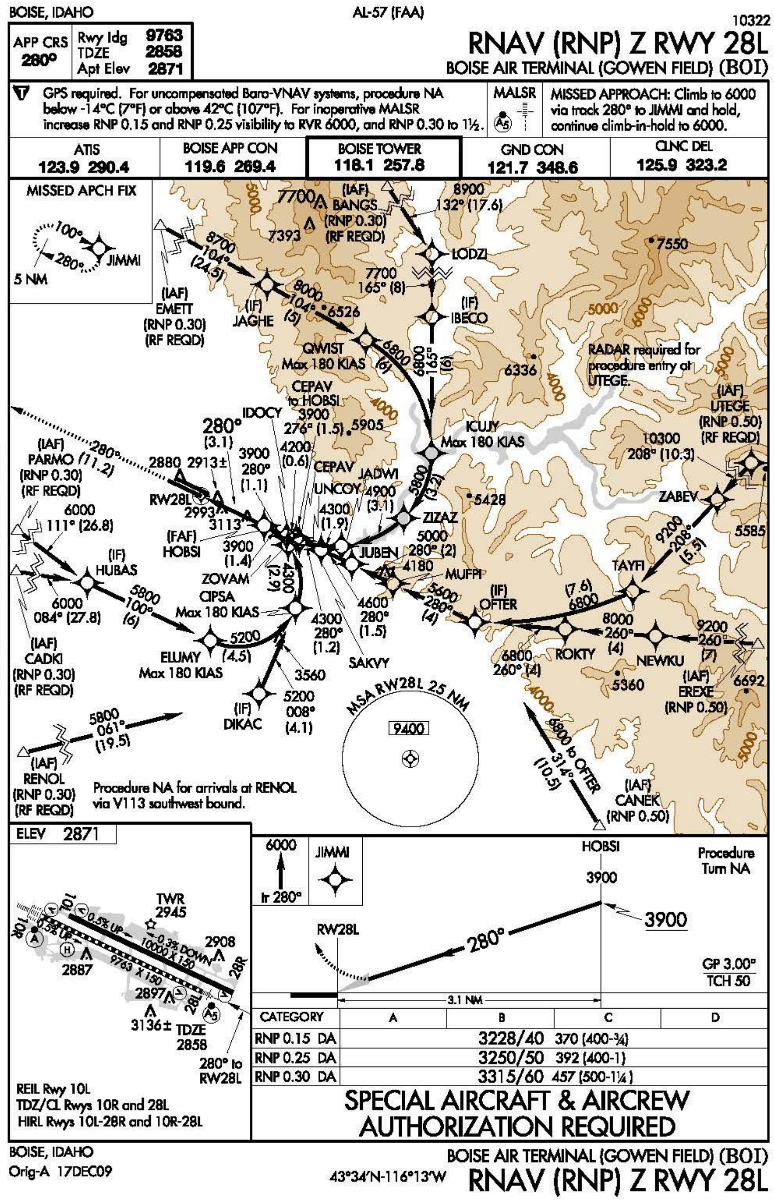

Figure 8. Example current RNAV (RNP) approach chart.

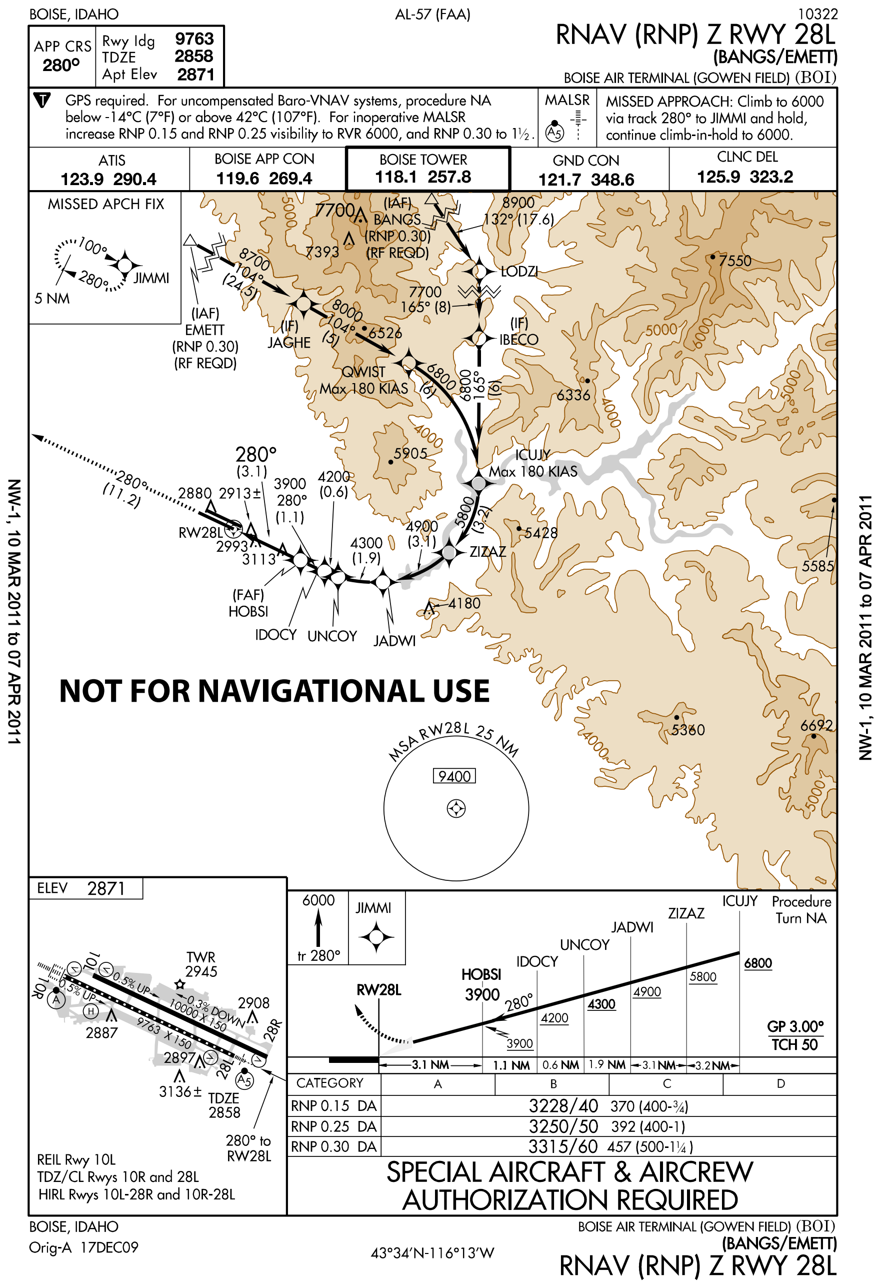

Figure 9. Example modified RNAV (RNP) approach chart.

4 Analysis and Results

Dependent variables were response time and accuracy. We also recorded comments during debriefing. We recorded the number of times participants viewed each chart image within a trial, but did not analyze these data.

Participants completed a short questionnaire at the end of the experiment that asked about their experience with the procedures tested in the experiment. These data were reported in Table 1. We also asked for feedback on the experiment and general feedback on RNAV and RNAV (RNP) operations. Additional information from the subjective feedback is in Butchibabu et al. (2012).

4.1 Response Time

Response time was analyzed in different ways. First, we analyzed the overall response times for current and modified charts separately for approaches and SIDs. Next, we examined how response times changed over the course of the hour-long experiment. Finally, we examined the relationship between the number of elements on the graphic portion of the chart (i.e., a rough estimate of "clutter") and the time required to find a specific piece of information from that chart.

As described in Section 3.3, response time is the time participants spent viewing the chart for each question. For questions that had two chart images (e.g., a graphic and a text page for a SID, or two graphic images for the Jeppesen Boise approach chart), viewing times were summed across all chart images viewed for each question. This yielded 98 response times for each participant (54 for approaches and 44 for SIDs).[3]

Two repeated-measures analyses of variance (ANOVAs) were performed, one for approaches and the other for SIDs. We performed the ANOVA on the log transform of the individual average response times for the analysis across participants. The log transform reduces the skew of the data distribution to more closely match assumptions of the statistical tests; it especially brings outlier responses more in line with the distribution of the remaining response times.

4.1.1 Main Effects on Response Time

Figure 10 shows the mean response times for current and modified approaches and SIDs. This average time combines performance on the different question types (e.g., speed, altitude, etc.). The average for the modified charts combines data across all the different modified chart images within a set for each airport. The main effect of chart modification was highly significant. Pilots were just over 6 seconds faster when using modified approach charts ($F_{1, 43} = 261.38$, $p < 0.001$) and almost 3 seconds faster with the modified SID charts ($F_{1, 43} = 56.68$, $p < 0.001$).

Figure 11 illustrates the main effect of airport, which was also significant ($F_{2, 42} = 44.17$, $p < 0.001$ for approaches and $F_{2, 42} = 5.96$, $p = 0.005$ for SIDs). Pairwise t-tests indicate that average times to find information for the Boise approach chart were significantly longer than average times for the other two approach charts regardless of whether the chart was in the current or modified format. Response times for Salt Lake City were significantly longer than for Dallas Fort-Worth and Las Vegas.

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[3] We discovered a spelling error in one of the questions for a Palm Springs chart in the experiment because some response times to this question were unusually long. As a result, we excluded data for this question from the analysis for all participants. We also excluded data for its matching question in the current chart. All other data, 98 response times per participant, were included in this analysis.

These results also show that the benefits of the chart modification were consistent across airports. Results of the pairwise t-tests indicate that the differences between current and modified charts were statistically significant for every procedure (Table 4).

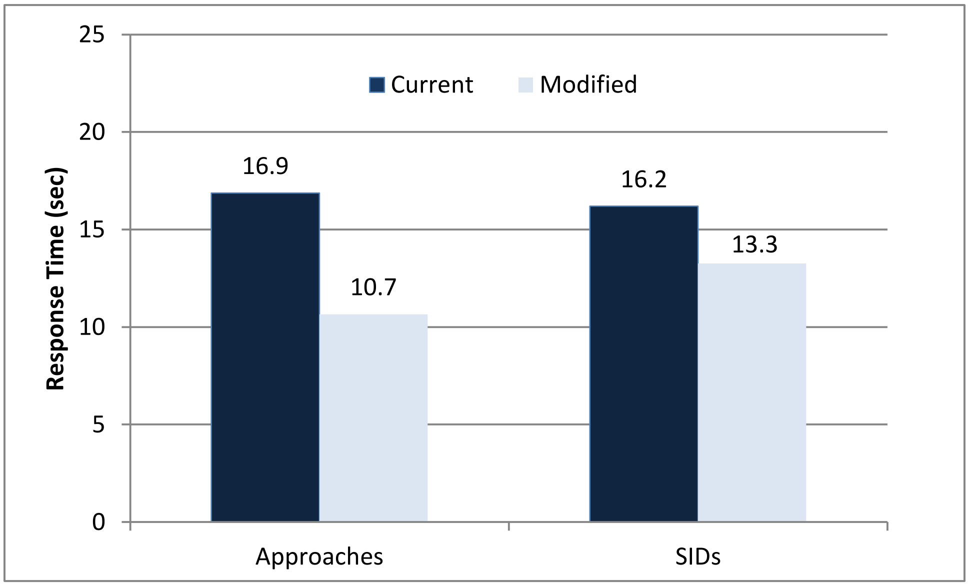


Figure 10. Mean response times for current and modified charts by type of procedure.

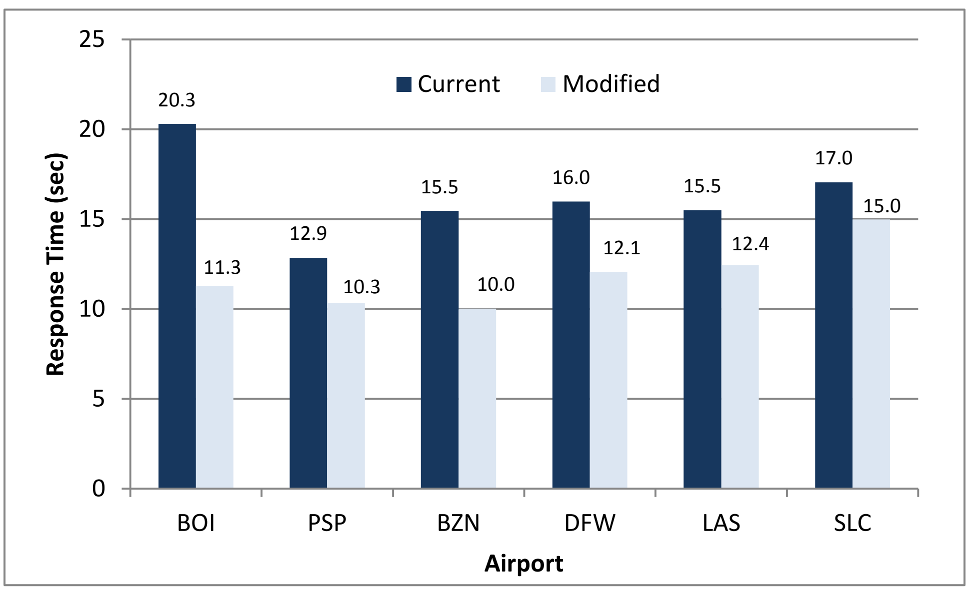


Figure 11. Mean response times for current and modified charts by airport.

Table 4. Mean response times for current and modified charts by airport.

Airport Code	Mean Response Time for Current Charts (seconds)	Mean Response Time for Modified Charts (seconds)	Statistical Comparison
BOI	20.29	11.27	$t_{46} = 14.1$, $p < 0.001$
PSP	12.85	10.32	$t_{46} = 4.6$, $p < 0.001$
BZN	15.45	10.02	$t_{46} = 10.0$, $p < 0.001$
DFW	15.97	12.05	$t_{46} = 4.2$, $p < 0.001$
LAS	15.49	12.43	$t_{46} = 3.7$, $p = 0.001$
SLC	17.05	14.98	$t_{46} = 3.4$, $p = 0.001$

4.1.2 Interaction Effects on Response Time

Some of the factors in this experiment were included to broaden the applicability of our results. In particular, we included Jeppesen and FAA charting conventions, and airline and corporate pilots, because we wanted to know whether the chart modification technique worked well regardless of charting convention and pilot type. If the modification technique only worked for some pilots, or some charts, then its utility would be limited. Our goal was neither to compare performance between airline and corporate pilots, nor to assess whether one charting convention yielded “better” performance than another. In fact, our use of the FAA charts was limited by the fact that none of the participants in the experiment were regular users of these charts. They did get refresher training, but their data may differ from those of regular users of FAA charts and is not valid for comparison with data from the Jeppesen charts. We cannot draw any conclusions about the operational validity of any differences between the two groups in this study.

In general, the direction of the effect was the same for participants, regardless of which charting convention they saw (FAA or Jeppesen), and regardless of pilot type (airline or corporate). In order to complete the ANOVA, however, we decided to account for the variances of the different factors (pilot type and charting convention). This resulted in some statistically significant interactions with these two variables. The results are detailed below.

4.1.2.1 Approaches

The ANOVA uncovered a significant Airport x Chart Modification interaction ($F_{2, 42} = 26.00$, $p < 0.001$). In other words, some of the airport procedures benefitted more from the modifications than others. Specifically, response times were significantly faster for the Boise modified charts than response times for Palm Springs and Bozeman for both FAA and Jeppesen charting conventions.

We also found a significant Airport x Charting Convention interaction ($F_{2, 42} = 7.20$, $p < 0.01$). This result, however, may be due to the fact that the participants in the FAA-chart condition were less familiar with that charting convention.

The three-way interaction for Charting Convention x Airport x Chart Modification was also significant ($F_{2, 42} = 7.32$, $p < 0.01$). This result suggests that certain airports benefitted more from the chart modifications than others and these benefits were specific to the charting convention. On average, FAA charts benefitted more from the modifications than the Jeppesen charts. In particular, the FAA Boise chart had the largest improvement in response time between current and modified. However, because the pilots who used FAA charts for the experiment were not as familiar with them, this difference could also be attributed their lack of experience.

4.1.2.2 SIDs

We found a significant Airport x Charting Convention interaction ($F_{2, 42}$ = 5.99, $p < 0.01$). This suggests that the ease of retrieving information from the charts varies by both the charting convention and the specific procedure. Again, these results may be suspect because of participants' lack of familiarity with the FAA charts.

The ANOVA also uncovered a significant Chart Modification x Pilot Experience interaction ($F_{1, 43}$ = 7.24, $p = 0.01$). This result suggests that corporate pilots benefitted more from the chart modifications than airline pilots, but we have no explanation for this finding. It may be an anomaly.

A significant three-way interaction was found for Chart Modification x Airport x Charting Convention ($F_{2, 42}$ = 7.54, $p < 0.01$). As with approaches, these results indicate that some airports benefitted more from the chart modifications than others and these benefits were specific to the charting convention. On average, our participants improved more with the modified FAA charts, but they were also less familiar with these from the start. Specifically, response times for the FAA chart for Dallas-Fort Worth improved the most with the chart modifications.

4.1.3 Response Time by Trial Number

We were interested to know whether response times varied systematically over the course of the experiment. A systematic decrease in response times would indicate that participants gained familiarity with the charts over time. A systematic increase in response times over the course of the experiment may indicate that participants were becoming fatigued. We tried to mitigate potential effects of learning by randomizing the current and modified trials within subjects and counterbalancing the approach and SID blocks between subjects. We tried to mitigate fatigue effects by providing a rest break between the approach and SID blocks.

To check whether our mitigations for learning and fatigue were sufficiently effective, we correlated trial number against response time. Trial number is a record of when the trial occurred within the experiment. Correlation coefficients were first calculated for each participant individually. Correlation coefficients vary between -1 and 1, with zero indicating no relationship. A negative correlation coefficient indicates that participant's response times went down as the trial number went up (learning) and a positive correlation coefficient indicates the opposite, that response times increased with trial number (indicating fatigue). These values were compared to zero using a two-tailed one-sample t-test.

The results of the correlation test indicated a small effect in the direction of learning, not fatigue. Response times systematically decreased over time for both SIDs (t_{46} = 9.37, $p < 0.001$) and approaches (t_{46} = 9.40, $p < 0.001$). Correlation coefficients for individual participants ranged from -0.39 to 0.16 with an average of -0.18 for SIDs and from -0.55 to 0.13 with an average of -0.19 for approaches.

4.1.4 Response Time by Element Count

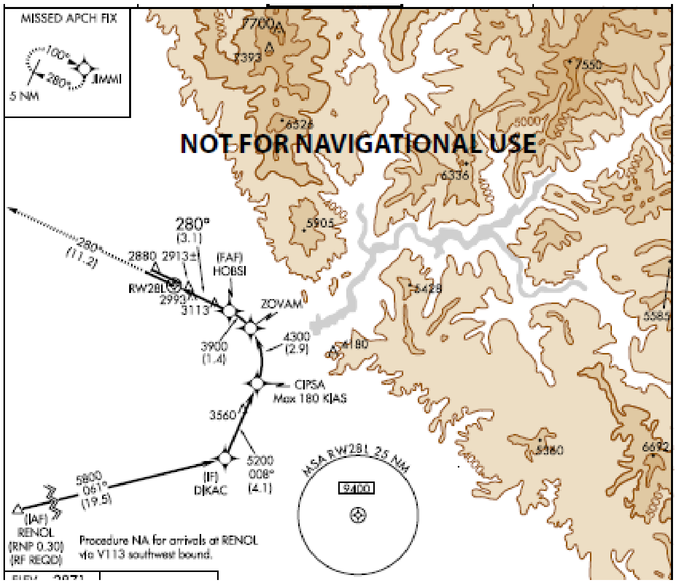
The main difference between modified charts and current charts was that some paths were erased to create the modified charts. In essence, we removed information from each current chart image at the expense of increasing the number of chart images needed to show the entire procedure. We hypothesized that the improved performance with modified charts could be modeled mathematically if we were able to quantify how much information was removed from each chart image. This hypothesis makes sense in the framework of a visual search task, where the participant considers one piece of information to be the “target” and all other elements as “distractors” (see Treisman & Gelade, 1980, Wickens & McCarley, 2008, and Wolfe, 1998). Often, visual search tasks find that search is random and serial; response time to find the target varies linearly with the number of distractors except in relatively specific situations where parallel processing can be effective (e.g., where the color of the target is unique among all the elements).

In order to quantify how much information was removed in the modified chart image, we constructed a simple metric for how much information was on the current chart image: the number of the elements in the graphic portion of the chart image (the main area where modifications were made). For approaches, we only counted elements in the plan view, and for SIDs we counted similar graphical elements, but these could be found anywhere on the graphical view. The actual metric was based on a count of elements on the FAA version of the chart. There may be some differences if the element count were based on the Jeppesen charts due to variations in the charting conventions. However, we expect these differences to be small because both manufacturers use the same source data to produce the charts, and because the differences of interest are likely to be *relative* (between current and modified charts), not absolute.

Table 5 lists all of the chart elements that we counted for this analysis. Each element was given equal weight; we just incremented the count by 1 for each element. A high element count indicates more data on the chart while a low count indicates a simpler chart image. For example the current Boise approach image had many chart elements resulting in a total count of 142, whereas modifications resulting in only one path on the image, such as the BOI Renol image, had a relatively low count (of 22). Figure 12 provides an example chart count for the BOI Renol image. As Table 5 shows, obstruction altitudes were not counted for the analysis because terrain elements were not modified in the chart prototypes. In other words, terrain information was a constant across the current and modified charts.

Table 5. List of chart elements counted for approaches and SIDs.

Approaches	SIDs
• Minimum En route Altitudes (MEAs)	• MEAs
• Headings	• Headings
• Distances	• Distances
• Waypoints	• Waypoints
• Altitude Restrictions	• Altitude Restrictions
• Speed Restrictions	• Speed Restrictions
• Notes	• Notes
• RF Legs	• Minimum Obstruction Clearance Altitudes (MOCAs)
• Holding Patterns	



Boise Renol Chart Image
4 MEAs
3 Headings
5 Distances
5 Waypoints
0 Altitude Restrictions
1 Speed Restriction
1 Note
2 RF legs
1 Holding Pattern
22 Elements Total

Figure 12. Example element count for BOI Renol transition, a modified chart image.

For this analysis, response times for each current and each modified chart image were calculated separately. For example, there were different response times for each of the five Boise chart images (the current image and the four modified chart images). Before computing these response times, we cleaned the data set by removing outliers. Outliers were defined conservatively as response times greater than 60 seconds (1.8% of approach trials and 1.8% of SID trials). We also removed one confusing question from the SID trials that had several excessive response times (1.6%).[4]

In computing the response times for each of the approach chart images, we also separated out results from ten questions for which the answers were located outside the plan view (e.g., those related to communication frequencies or airport elevation) because we did not modify these sections of the chart. In fact, our hypothesis was that there would be no correlation between response time and the element count for these questions. This hypothesis was confirmed; there was no significant relationship between the number of elements on the image and the response time for these ten questions ($r = 0.048$, $p = 0.38$). This result indicates that pilots could find information outside of the plan view on approach charts just as quickly regardless of the number of elements in the graphic view.

For the remaining questions, which did refer to information in the graphical elements of approaches and SIDs, our analysis indicates a strong positive linear relationship between the number of elements and response times. For approaches, the correlation coefficient was 0.86 and for SIDs, 0.88, both highly statistically significant ($p < 0.001$). The correlation coefficient across SIDs and approaches combined was 0.80, again a statistically significant result.

Regression lines fitting these data reflect similar findings (see Table 6 for slopes and intercepts). The slope of the regression line indicates the incremental cost in response time for each additional element

[4]This question was shown only for the Jeppesen Salt Lake City Leetz charts. It asked for the distance from the airport to the PIGG waypoint. The answer was in a note in the upper left corner of the chart, far from both the departure airport and PIGG, which were in the lower section of the chart.

on the chart. A two-sample independent t-test on the slopes for SIDs and approaches found no difference (t_{21} = 1.36, p = 0.155), meaning that the slopes were statistically equivalent for approaches and SIDs. Therefore, using a single regression equation for both is appropriate. Response times from both approach and SID charts relative to element count, and the best-fit line, are plotted in Figure 13. Appendix D contains a list of all the element counts and their associated mean response times, with outliers excluded.

4.2 Accuracy

We scored pilot responses for accuracy manually. In most cases, scoring was clear cut. We were flexible about formatting and abbreviations, and accepted more than one correct answer for one question (see Appendix B). Pilot responses such as 19.25 and 11925, for example, were both accepted for the communication frequency of 119.25. If necessary, two or more researchers reviewed the response. Unanswered questions (a total of five across all subjects) were scored as incorrect.

As mentioned earlier, there were 98 response times per person from 54 approach questions and 44 SID questions. However, there were four trials for which the participants in the FAA-chart condition saw different questions from subjects in the Jeppesen-chart condition (one approach question and three SID questions). So, we actually collected data on 102 different questions. Four of the questions had data for only the 14 participants in the FAA condition and four other questions had data from only the 33 participants in the Jeppesen condition.

The vast majority of questions, 85 out of 102, were answered with better than 90% accuracy. Of the 17 remaining questions, 11 were related to altitude questions, so we examined these further. The last six questions with lower accuracies did not indicate any particular trend or pattern and are not discussed.

	Approaches	SIDs	All Charts
Intercept	8.1 sec	8.0 sec	8.5 sec
Slope	0.087 sec	0.061 sec	0.066 sec

Table 6. Linear regression parameters.

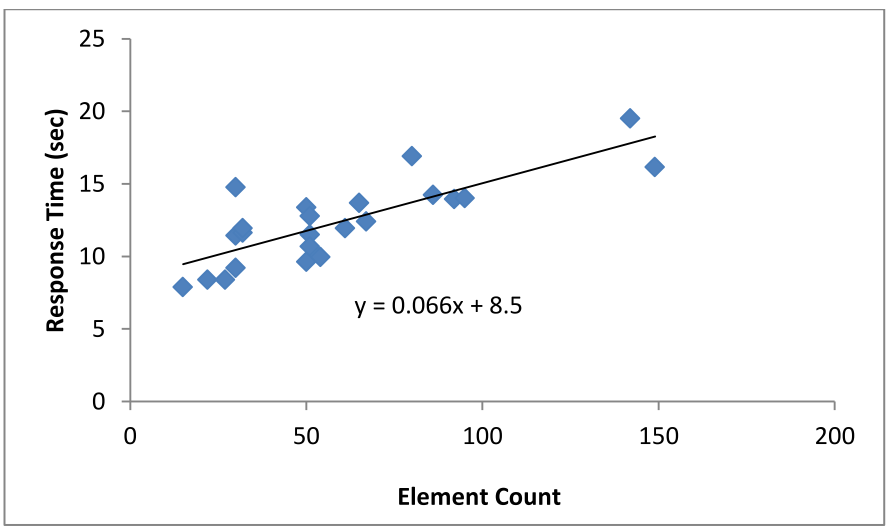


Figure 13. Scatterplot of response time by element count for approaches and SIDs with regression line.

Table 7 shows a list of the results for all altitude related questions in the study, broken out by type of altitude in the correct answer and by percent of correct answers (above or below 90%). Two of the altitude questions referenced an outdated convention for indicating procedure altitudes for use by ATC. We decided to exclude these questions because of the known confusion with this convention. Interestingly, however, the poor accuracy results may have replicated the operational confusion experienced with the "ATC altitude" notation.

Participants had no difficulty with the two mandatory altitude questions and seven of eight Minimum Enroute Altitude (MEA) questions. The one MEA question that fell below the 90% criterion, with 85% correct, was from one of the most cluttered charts (Boise). The most common incorrect responses were the adjacent MEA or the distance between the two waypoints.

Participants had the most trouble with eight questions related to "at or above" or "at or below" altitude constraints; every one of these eight questions fell below the 90% accuracy threshold. Sometimes, participants responded with only a single altitude, which we interpreted as a "mandatory" altitude, because above or below were not indicated. However, upon further examination, we found that five participants did not indicate "above" or "below" in *any* of their responses, which implied that they may have misunderstood the task. We decided to exclude data from these five subjects for just the altitude questions that used the above/below indication.

Table 7. Results for all altitude questions including all data.

Question Type	Number of Questions with Accuracy Above 90%	Number of Questions with Accuracy Below 90%
Mandatory Altitude	2	none
At or Above	none	3
At or Below	none	5
Minimum en Route	7	1
Reference to "ATC" altitude	none	2

Table 8. Responses to the most error-prone altitude-constraint questions.

	Subject Response			
Correct Answer	At or Below	At or Above	Altitude only	Other
At or Below, CUPOL (PSP)	64%	2%	19%	14%
At or Below, HIXOV (PSP)	55%	5%	36%	2%
At or Below, CHEDO (SLC)	86%	10%	5%	0%
At or Above, HUCKK (SLC)	2%	88%	5%	5%

After cleaning the data, we found four altitude questions that still had accuracies below 90%. Two questions had accuracy rates of just 64% and 55% across the FAA and Jeppesen charting conventions

(Table 8). Both of these asked for an “at or below” altitude constraint on the Palm Springs approach chart. “At or a below” constraints are uncommon on approach procedures, where pilots usually stay “at or above” given altitudes, for terrain avoidance. Performance on the two other questions, from the Salt Lake City Leetz departure improved considerably after excluding the subjects who did not indicate above/below altitudes.

5 Discussion

The main finding from this study appears to be relatively clear: simpler, modified charts yield faster times to find information. However, underlying this straightforward result is a considerable amount of subtlety in its interpretation. Here, we discuss the interpretation of this result and several other issues that need to be addressed before a conclusive recommendation can be made.

5.1 Task Fidelity

The experiment task was to answer discrete questions using a chart image on a computer screen. Does this task correspond well to how charts are used operationally?

Clearly, one difference between our task and real operations is that pilots typically use paper charts (or smaller electronic displays), not large desktop monitors to view full-sized chart images. We used the computer presentation so that we could measure response time accurately. Our focus was on measuring the benefits of the modification technique for retrieving data from the chart content. These benefits will be independent of the paper format or electronic display presentation because they are directly related to the chart content, which does not change. A different study could have been designed around the use of paper charts. That study would have to consider a variety of other factors, such as how to ensure accurate timing and the practical constraints of paper charts (e.g., bound versus loose presentation, paper size, physical layout of the available space, etc.). These factors would make it more difficult to measure and compare time to find specific information from the chart.

Our use of discrete questions also impacts the fidelity of the task. Discrete questions provide control and easy measurement, and they reflect one type of task for which pilots refer to charts. Therefore, we feel that these questions are a valid measure of performance with the modified charts. However, there are operational factors that we did not consider in this study that render the discrete task an incomplete measure of pilot performance. For example, pilots use charts to get an overview of the procedures and the options available to them, not just to find discrete information. We did not measure how well the modified charts support general position awareness and route planning. Also, in a more realistic operational situation, the pilot would have been in flight and therefore more fully aware of his or her position when the request for information arrived, unlike the experiment questions, which were about noncontiguous locations from one trial to the next. Additional route context may better prepare pilots to find the desired information more quickly.

In addition, in real operations, the pilot may have to find the correct chart image from either the paper set or an electronic database if the procedure were not already selected and available as in this study. However, time to find the chart does not trade off directly with time to retrieve information from a given chart. In some cases, the search task could slow the pilot down, but there are ways to reduce the impact of time to search for a chart. For example, pilots usually identify and set aside charts that they might need when they are not busy (e.g., on the ground, pre-flight), which simplifies the search task by making the charts that are most likely to be used ready for quick and easy access. The difficulty of the chart search task could also be mitigated by a well-designed and industry-standardized chart-naming convention. Conversely, if the required procedure were already programmed into the Flight

Management System (FMS), pilot response may be faster than expected because the information might be more readily available from the FMS or the navigation display than the chart. Having a second pilot to assist with the task would potentially also impact the time to find information from a chart.

All of these operational factors increase the variance of the dependent variable, response time for finding specific information. Therefore, additional operational context would make it more difficult to examine the effect of the chart modifications. Other variables may need to be recorded in a study of higher fidelity, such as where the information was found, which pilot found (or remembered) it if there are two crew members, etc. These variables greatly increase the complexity of the study and may make the findings from higher fidelity studies difficult to interpret.

This tradeoff between experimental control and operational fidelity is a familiar one. Our opinion is that, for this first-look experiment, our protocol was satisfactory. The response time variable is sufficient for making gross comparisons between the test conditions, even if the actual response time would be different in higher fidelity conditions.

5.2 Generalization of Findings

The main result of this study is that pilots were able to find information from modified charts more quickly. We found that a simple measure of clutter, the count of specific visual elements in the graphic depiction, is linearly related to the response time for finding information. This is an effective way of comparing the charts. The charts selected for the study were specifically chosen for their high clutter levels, but our results with the modified (simpler) charts show that the linear relationship between our clutter metric and response times holds even for less cluttered charts. These findings are believable and they are likely to be robust for this task within the framework of a visual search task, as explained in Section 4.1.4.

There are limitations to the usefulness of this measure of chart clutter. For example, our clutter metric is only useful in a relative sense; it does not describe “absolute” clutter of the chart image because it does not consider elements such as the terrain contours and peak altitudes that were constant between current and modified chart images. Also, our clutter measure records the total clutter on the chart, but does not distinguish between local and global clutter. Clearly, some parts of a chart are more or less dense than others. Specific chart layouts (e.g., local density, scale) could therefore affect response times, at least secondarily.

Another implication of the linear relationship between clutter and response time is that we do not expect to be able to find a cutoff point at which there is “too much” clutter because clutter rises at a constant rate. If there were a cutoff point at which a small increase in clutter produced a large increase in response time (i.e., if there were a nonlinear relationship between clutter and ease of use), then it might have been possible to determine a criterion by which to separate charts that would benefit greatly from the modification technique from charts that did not benefit as much.

As it is, further analysis would be needed to develop criteria for implementing the modifications if they are adopted. The criteria may need to consider factors that we did not consider in this study such as how difficult it is to fly the procedure and whether the depiction is confusing operationally. Chart manufacturers may need specific guidance to decide when or when not to use the technique because over-use of the technique could impede pilot performance due to the practical considerations mentioned earlier (Section 2). We expect that simple charts with relatively few elements in the graphic depiction are not likely to benefit from the modifications as much as visually dense charts, but did not test this case in the current study.

We do expect that the findings from this study could be generalized in a number of ways. Each of these generalizations would need to be validated with new data. First, we expect that the findings could be generalized to other types of charts; the findings are probably not specific to RNAV and RNAV (RNP) procedures. The modification technique could help to improve the depiction of visually dense conventional procedures as well.

Second, we expect that the results are not specific to RNP qualified pilots, but could be replicated with other pilots who might use these charts. In particular, pilots with RNAV qualifications only (i.e., not RNP-qualified) would probably yield similar results. Because the number of pilots with RNP qualifications is low, it was difficult to find participants to complete this study. It would be helpful to know whether RNAV qualifications alone provide a representative sample of participants because that would greatly ease access to participants.

Finally, our protocol employed only a single pilot for the task. As a consequence, we expect that our findings would apply to single-pilot operations, including typical general aviation operations.

5.3 Lessons Learned

During our independent analysis of the experiment and resulting data, we found several aspects of the experimental method that we would improve were we to rerun the same experiment again.

5.3.1 Coding Issues

We chose to use the MATLAB® programming environment because of its simple coding interface. However, this was not a good choice because it restricted portability because participants had to use a computer with a MATLAB® license. We recommend that the code be rewritten in a web-based language (or other portable platform) so that the experiment could be run easily on different computers and even potentially be run as an online study.

Although we spent considerable time pre-testing the software, there were problems we did not identify before data collection. For example, we intended to record and analyze the number of times each chart was viewed. However, we were not able to thoroughly test the code to verify that these data were recorded correctly. Second, upon close analysis of the data files, we discovered that the trials were not randomized properly. Instead of each participant receiving an individually randomized trial sequence, there were just six different trial sequences that were shown across all 47 participants. Trials should be randomized differently each time the experiment is run. Finally, the response entry method that required two clicks confused some subjects. Only a single click should be required to activate the text box.

5.3.2 Image Quality

Subjects reported difficulty reading the charts on the display. In retrospect, we believe that this difficulty was because the monitor we used displayed only about 90 pixels per inch and because the images were shown to subjects as bit maps instead of in Portable Document Format (PDF). A higher resolution monitor should have been used and the images should have been matched to the monitor resolution if they were bitmaps.

5.3.3 Question Set

The following recommendations would improve the question set.

- Based upon our analysis of the learning effect (i.e., the correlation response time by trial number), we recommend that the number of questions be reduced in the study. In particular, we would reduce the number of questions per procedure.
- The questions varied in a complicated way that was not fully balanced or consistent between current and modified charts, and between Jeppesen and FAA chart conventions. This added unnecessary complication to the experiment design and analysis. A simpler question-type scheme should be used.
- Although question types were conceptually matched between the current and modified charts, the matched pairs should be pre-tested to determine if some were more difficult than others. We suspect that much of the residual error in the regression analysis of element count and response time may have been due to differences in the difficulty of questions.
- Upon close inspection, we discovered that some of the questions were not well constructed. For example, one question asked about required equipment other than GPS, but in fact, there was no other required equipment. This confused participants and increased the difficulty and scoring of the task. Confusing questions should be identified and revised or eliminated.

5.3.4 Other Considerations

One participant suggested using the Jeppesen and FAA chart conventions as a within-subjects variable, meaning that all subjects would see both types of charts. This would have helped to balance the data obtained on the different chart conventions and would have better equated the two conditions in that all participants would see the FAA chart refresher training. However, it would also have increased the duration of the experiment per participant unless there is a corresponding substantial reduction in the number of questions.

Another participant asked that charts with more than one image be presented side by side rather than having a button to toggle between them, essentially asking for a more paper-like viewing option. This would require additional monitor display space, but would eliminate the need for the participant to select the image they wanted to see.

5.4 Assessment of Modification Technique

The modification technique appears to be useful in reducing the time to find information from specific charts, given the caveats above about task fidelity, generalization of findings, and lessons learned. Our conclusion is that there are some procedures for which the technique is helpful. We expect that the benefits of this technique would extend to electronic chart applications that can remove information from charts quickly and effectively. For example, the modifications made in this study are similar to modifications that could be made in real-time if the electronic chart application has knowledge of the planned route of flight. Path segments that are not being flown could be removed to improve the usability of the chart. The modifications could be made automatically by the software logic, or the user could change the display configuration as desired. Further enhancements to the electronic depiction could also be implemented, such as chart layers that could be turned on and off easily.

However, the modification technique used in this experiment was designed to determine the benefit of just one isolated factor: separating paths across multiple images to reduce the number of paths shown per image. There are other modification techniques that could be tested. For example, a logical next step is to zoom and re-center the charts for optimal use of the available space. This enhancement may, or may not, further improve information retrieval performance. Evaluations are needed to ensure that zooming and re-centering do not impede performance in unexpected ways. For example, it may be difficult to orient oneself across chart images if they are at different scales with different centers. This could be an issue if the pilot is asked to maneuver from a flight path on one image to a flight path on a different image.

Our modification technique worked well for procedures with multiple paths. However, it will not work for procedures that are complex in other ways. For example, the FRDMM and TRUPS arrivals, which are RNAV optimized profile descents into Washington National airport, each have only one route on the chart image, but that one route has many more waypoints and constraints than usual. It is not possible to simplify these arrivals in the way that worked well for the procedures in this study. An alternative technique that has been used in these cases is to separate the chart images by distance to the airport.

5.5 Recommendations for Follow-on Studies

This section presents our suggestions for next steps. One option is to validate and extend the findings of the current study to further explore the benefits and limitations of the chart modification technique. Another option is to pursue variations of the current experiment that have a different focus. The third option is to pursue a different research question related to charting of procedures that use RNAV and RNP. We consider each of these directions.

5.5.1 Validation and Extension of Current Experiment

For this goal, a necessary first step is to address the lessons learned to collect a cleaner data set and replicate the results from this study. The second simple and useful step is to devise and implement an improved response-entry method. For example, pilots could simply click on the information in the chart to respond. This would help determine whether pilots prefer to use the profile view or the plan view to find information that appears in both sections of an approach chart. This method could also help to understand how often FAA SID text pages are selected and viewed as opposed to graphic pages.

Another simple step to improve the experiment without significant changes would be to generalize the subject population. For example, most regular users of FAA charts are not RNP qualified. Testing these pilots would increase the face validity for data on FAA procedures. It may be useful to test RNAV qualified pilots in general also to understand whether the results can be generalized to pilots who are not RNP qualified.

5.5.2 Variations on Current Experiment

One way to vary the experiment is to select a different set of procedures for the study. The new procedures would drive the type of research questions that are addressed. Other types of procedures and other chart modification methods could be tested. For example, different de-cluttering methods may be needed to address single-path procedures such as the FRDMM and TRUPS arrivals mentioned earlier. In either case, if new procedures are tested, then it would be interesting to check whether the same clutter metric proves useful.

Simpler chart modifications such as zooming and centering different charts for a procedure that is separated across images could also be tested to determine whether the changes affect the pilot's ability to transition between images. This study may require a higher fidelity operational task with a simulated air traffic control capability to motivate the pilot to switch chart images.

A more significant change to the study is to shift the focus to evaluate the time it takes to search for the correct chart image. This test could be done with lower or higher fidelity tasks. A low fidelity option is to have subjects choose which chart to view based on the chart title (text) from a list presented on a computer screen that might represent a control and display unit for an FMS. Higher fidelity options include working with paper charts in a simulator. If the higher fidelity options are chosen, many tradeoffs and complexities have to be resolved for the experiment design. The main problem in the high fidelity environment is that use of a chart is a low priority task within the full context of managing a flight. The task of using the chart is likely to be mingled with other, higher priority, tasks, making it difficult to use time as the main dependent variable.

5.5.3 Alternative Research Questions

Some alternative research questions came up during the interpretation and analysis of the current study. For example, it may be important to address chart naming conventions in depth. A clear and consistent chart naming convention could help pilots find chart images quickly in general.

It may also be important to delve into the issues surrounding depiction of altitudes and altitude constraints. To study the depiction of altitudes and altitude constraints, the next study would have more altitude questions and it would balance the types of altitude questions (mandatory vs. window vs. above/below altitudes). This study could evaluate the information content of altitude data and perhaps explore different ways of depicting altitude constraints (e.g., through text labels vs. graphic depictions).

Another question that could be explored is how pilots use information on the chart images in the context of a modern flight deck. It would be especially interesting to examine the use of SID and STAR charts in this experiment because they are less structured than approach charts. Pilots could be observed in realistic scenarios in a more naturalistic environment, such as a fixed-base training simulator, to understand what information is used from the chart and when. There is anecdotal evidence that pilots are more dependent on the flight deck system to fly instrument procedures than they were in the past. This study may be able to provide data to support or refute the anecdotal evidence. However, if even a fixed-base simulator is used for the study of chart information use, fidelity issues need to be considered and addressed.

Finally, an important distinction to understand is the difference between procedure complexity and chart complexity. A chart is the depiction of a procedure (Chandra et al., 2012) and the procedure is a set of instructions about the route of flight. If a procedure is complex to fly, it may or may not produce a chart that is visually complex to use. Understanding procedure complexity, both subjectively and objectively, will be an important step towards making charts more usable. Additional research is planned to better understand the factors comprising perceived complexity of these instrument procedures.

6 Summary

We gathered data on the retrieval of information from current and modified RNAV (RNP) approach charts and RNAV SID charts from 47 RNP-qualified pilots with airline and corporate flight experience. Our results show that pilots find information faster from the modified charts with fewer paths displayed per image than from current charts that contain all paths on one image. These results are consistent across all six airports in this study, for both corporate and airline pilots, and across both Jeppesen and FAA charting conventions. Our findings can be modeled as a serial visual search task; response time increased linearly with element count in the graphical depiction of the route.

We found that pilots misinterpreted altitude information in some cases. Pilots may have misinterpreted the “at or below” altitudes on the approach because they violated routine expectations, because they misread the graphic depiction of the constraint, or because altitudes are inherently complex data. There is little data on this issue, but perhaps enough to warrant a more focused study to determine whether the error rates with altitude questions indicate a real issue, and how to address this issue.

Several recommendations for follow-on work are provided. While this study provides evidence for a performance benefit with the modified charts, practical considerations and other questions related to the design and depiction of new PBN instrument procedures remain to be addressed.

7 References

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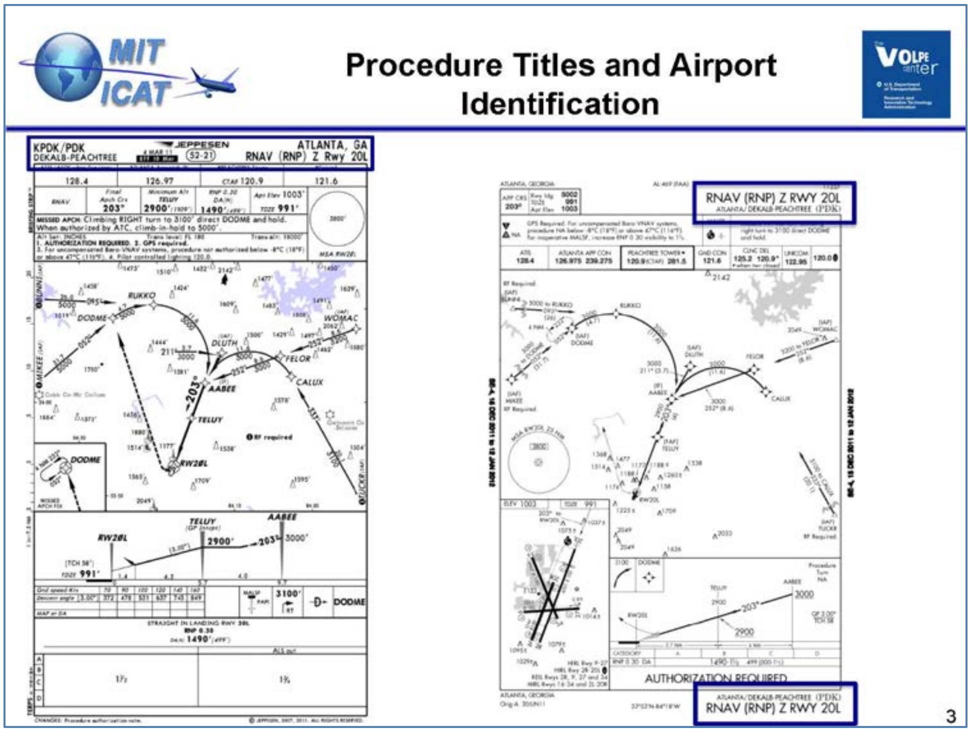
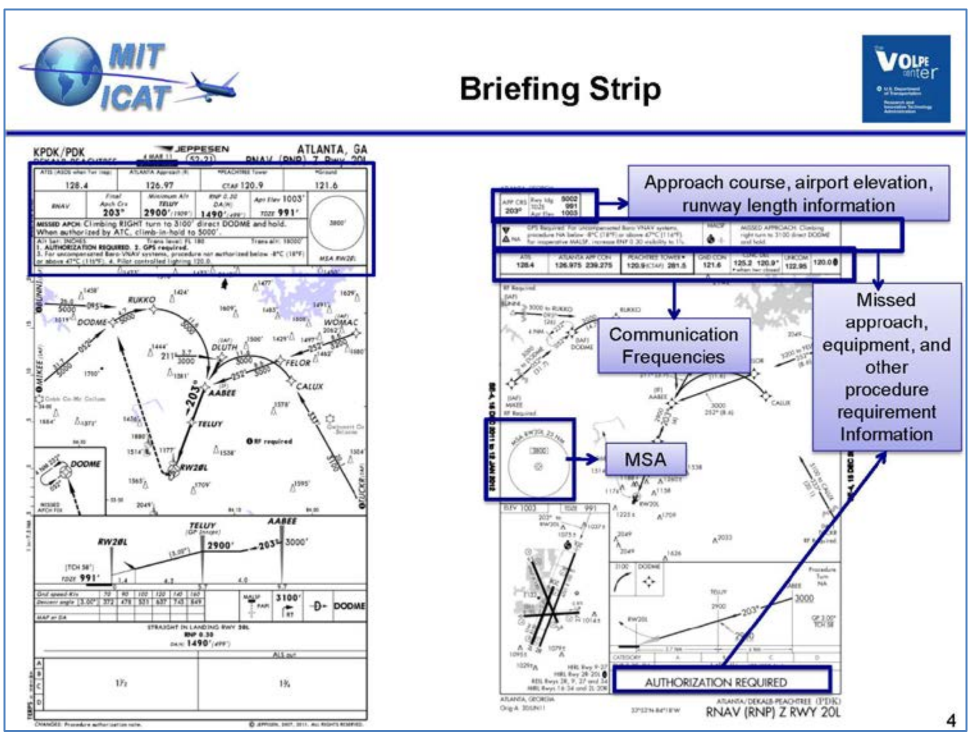
Appendix A: FAA Chart Refresher Training

FAA Chart Refresher

Part 1: Instrument Approach Procedures (IAP)
Part 2: Standard Instrument Departures (SID)

Part 1:
Instrument Approach Procedures (IAP)





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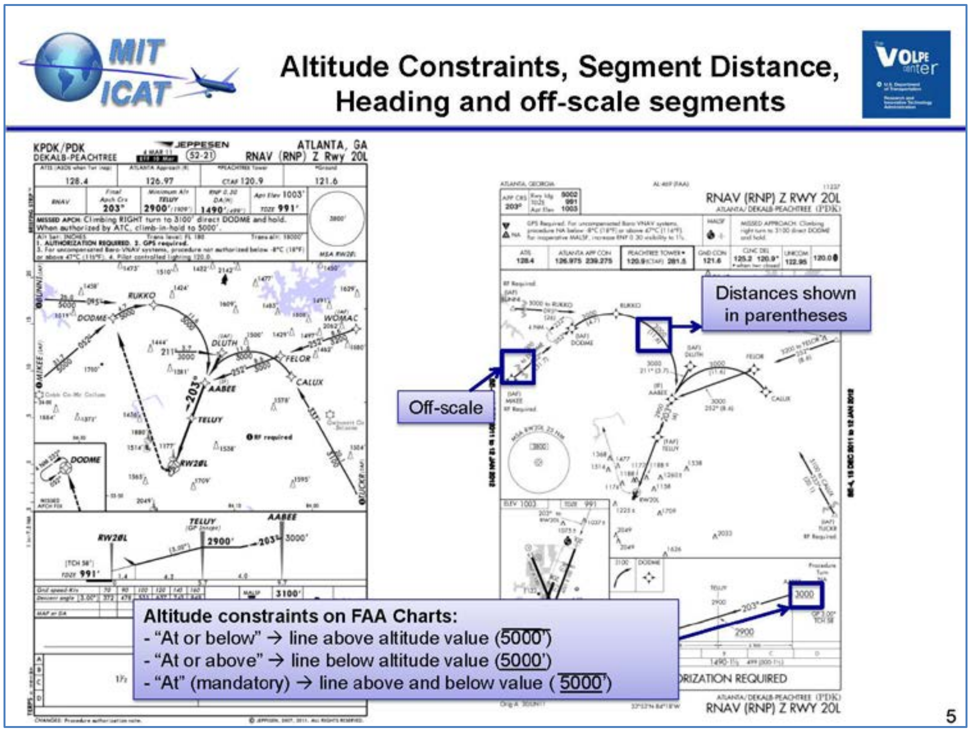
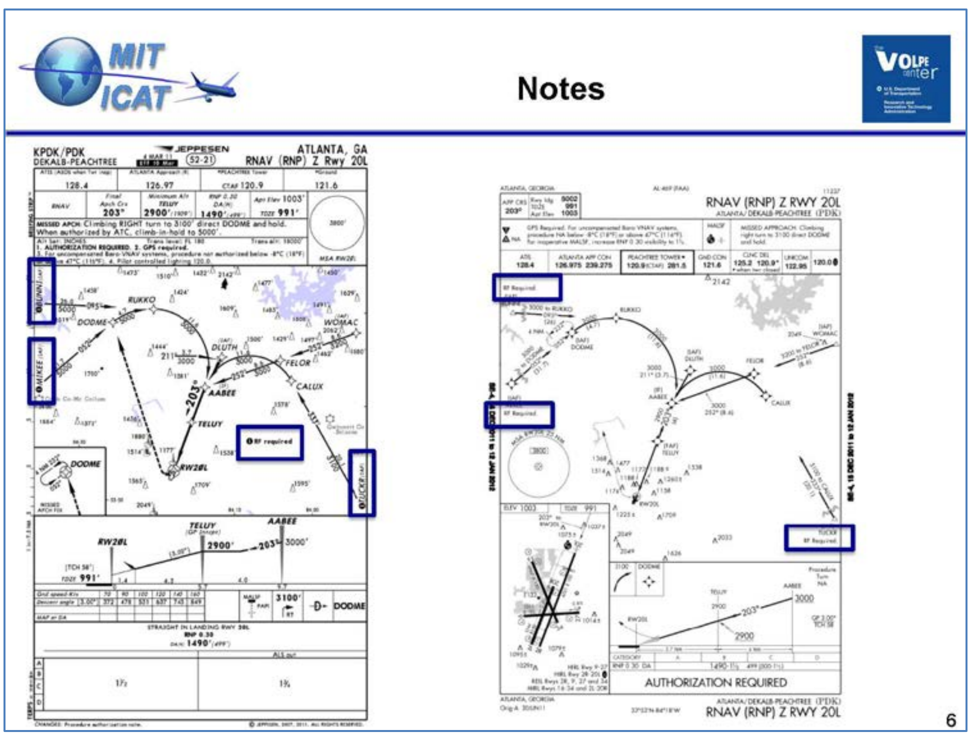
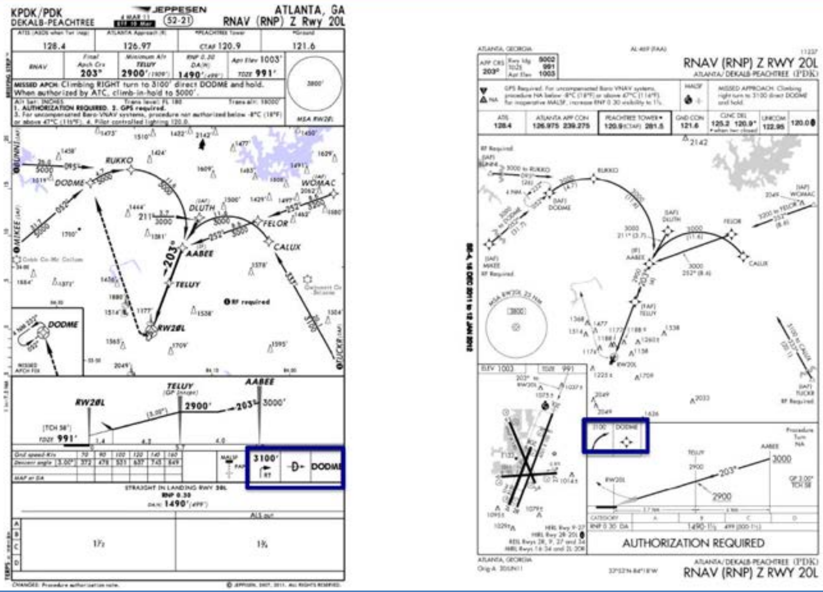

MIT ICAT
Altitude Constraints, Segment Distance, Heading and off-scale segments
Distances shown in parentheses
Off-scale
Altitude constraints on FAA Charts:
- "At or below" → line above altitude value (5000')
- "At or above" → line below altitude value (5000')
- "At" (mandatory) → line above and below value (5000')
RNAV (RNP) Z RWY 20L
5

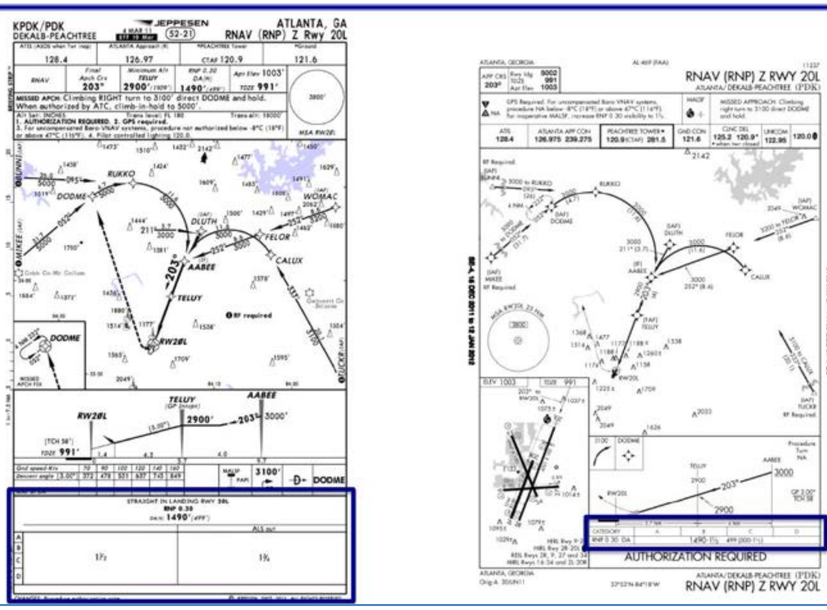

MIT ICAT
Notes
RNAV (RNP) Z RWY 20L
AUTHORIZATION REQUIRED
6

Missed Approach Icons



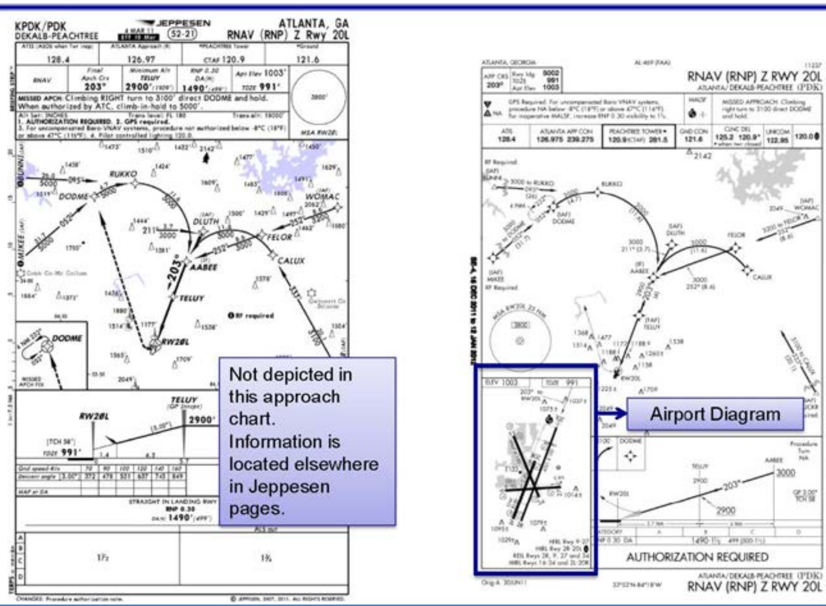
7

Decision Altitude and RVR



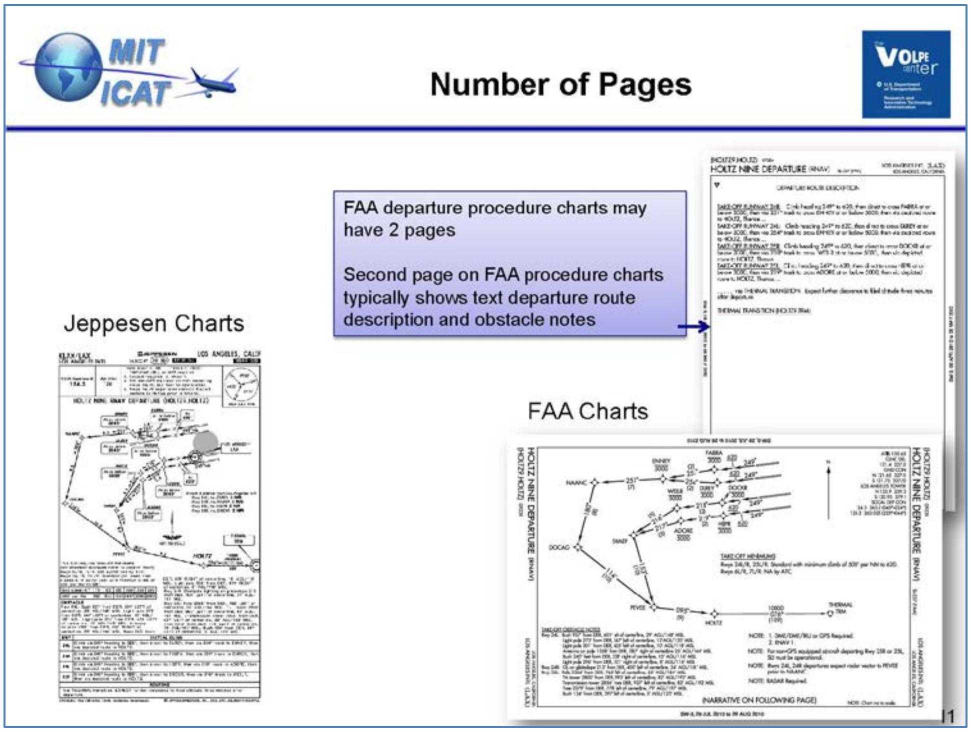
8

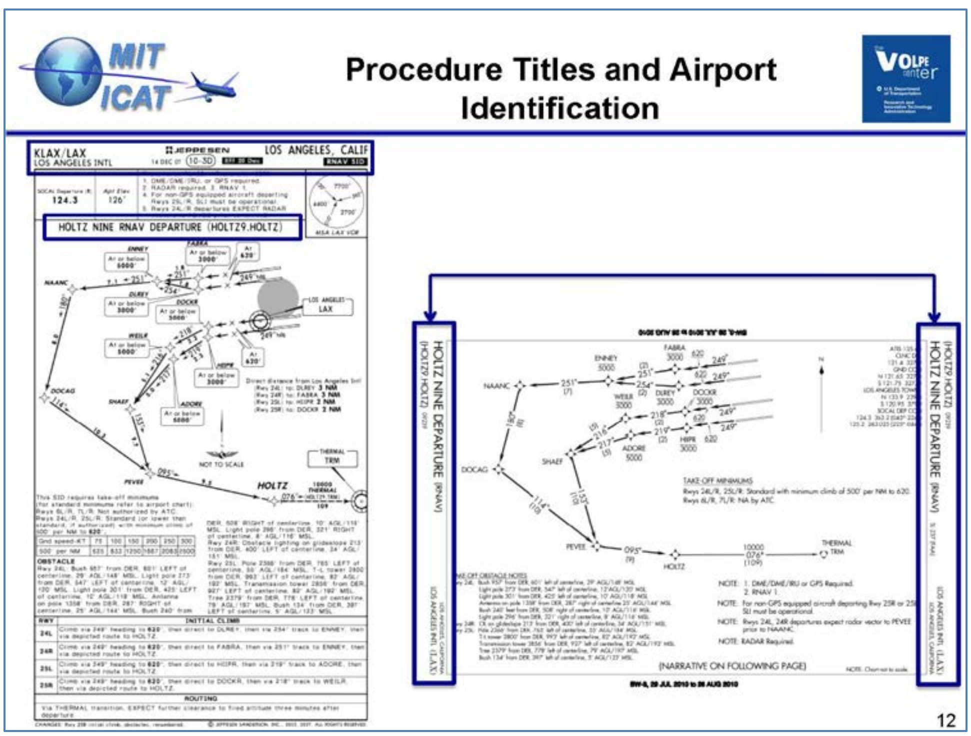
Airport Diagram

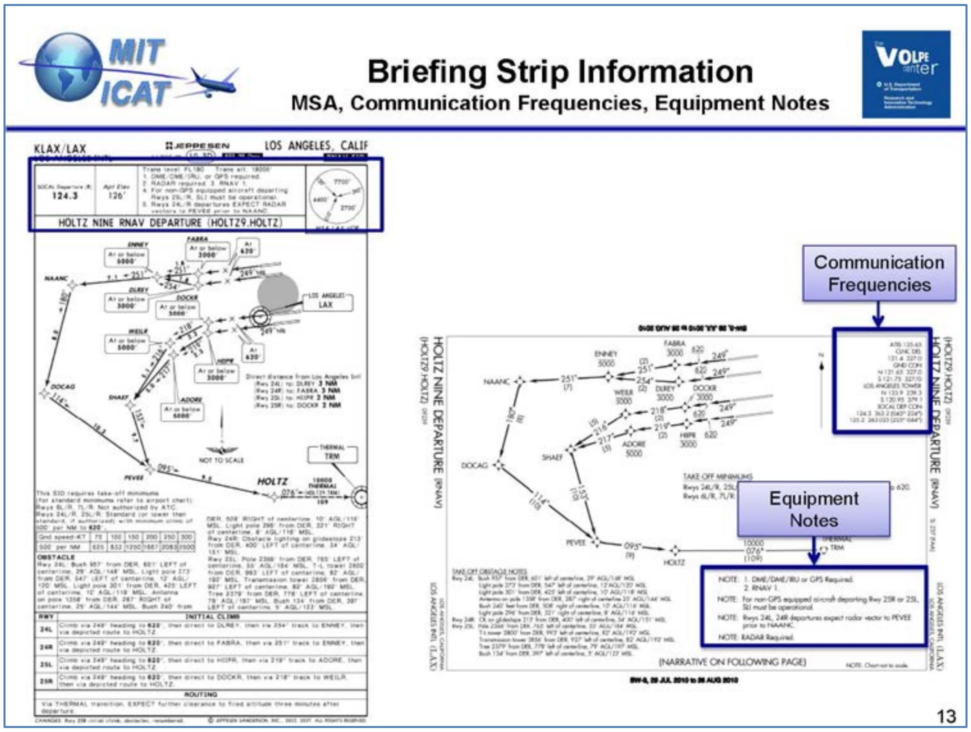


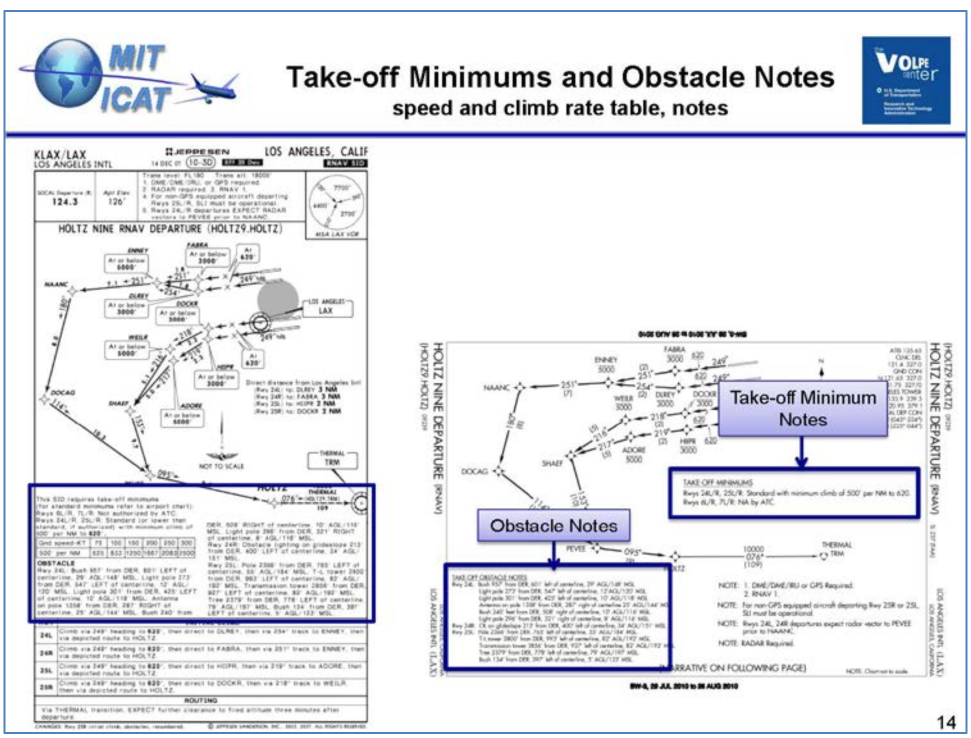
9

Part 2:
Standard Instrument Departures (SID)


MIT ICAT
Number of Pages
FAA departure procedure charts may have 2 pages
Second page on FAA procedure charts typically shows text departure route description and obstacle notes
Jeppesen Charts
FAA Charts
11


MIT ICAT
Procedure Titles and Airport Identification
KLAX/LAX
LOS ANGELES INTL
LOS ANGELES, CALIF
HOLTZ NINE RNAV DEPARTURE (HOLTZ9.HOLTZ)
HOLTZ NINE DEPARTURE (RNAV)
(HOLTZ9.HOLTZ)
LOS ANGELES INTL (LAX)
12





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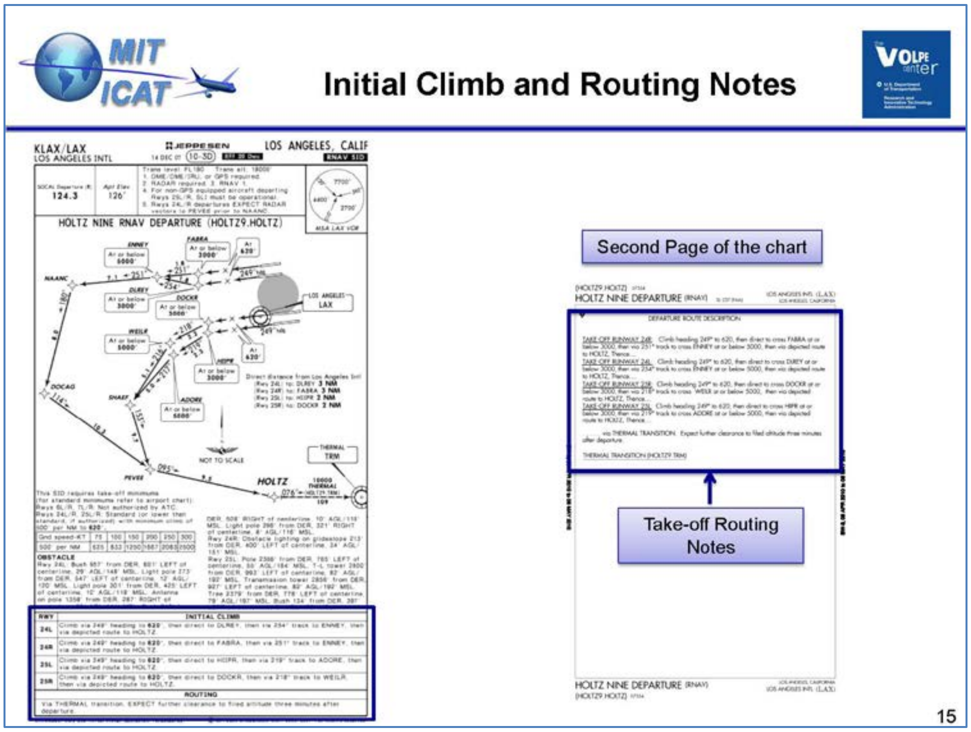

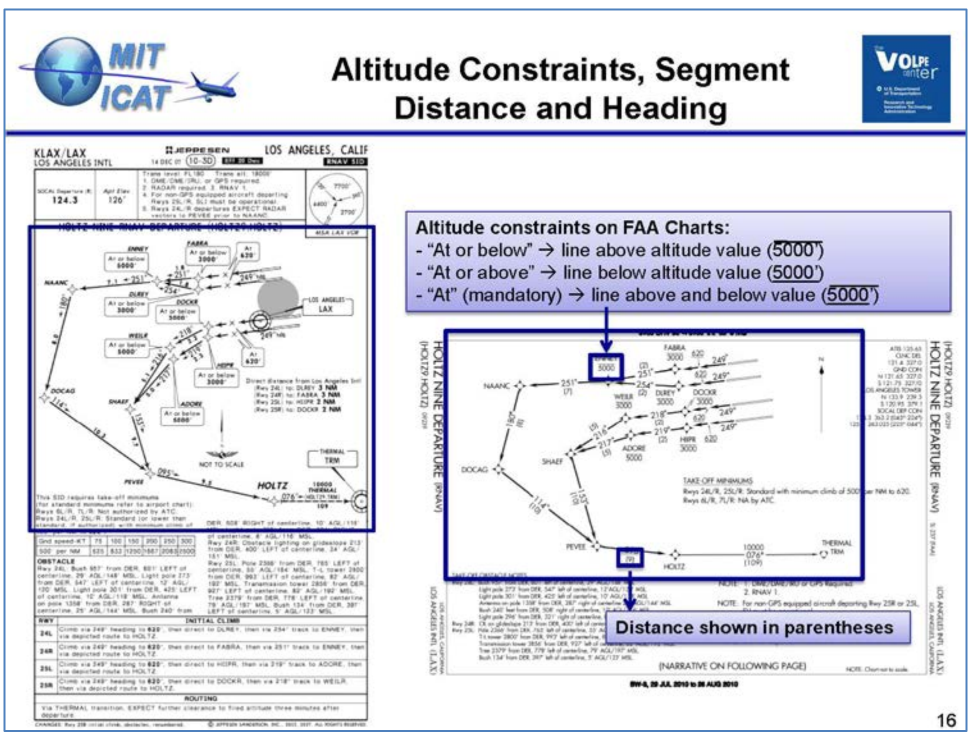

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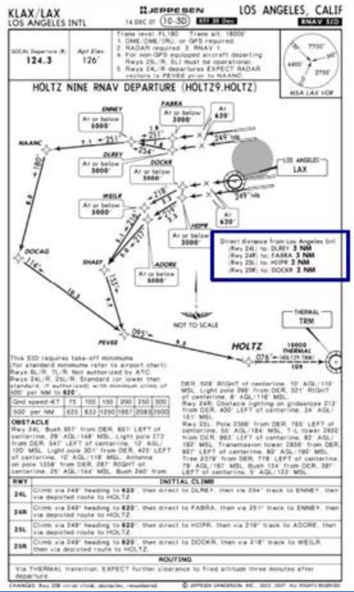
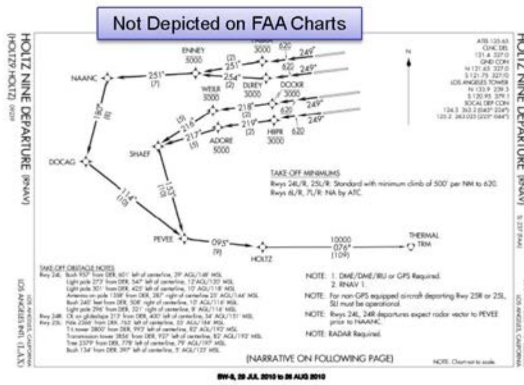
Direct Distance from Runway to Initial Fix





17

End of Refresher

Any questions?

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Appendix B: Trial Details

The following tables show all the questions in the experiment. In most cases the answers to the questions were the same for both Jeppesen and FAA charts. However, we found that Jeppesen charts show distances to tenths of a nautical mile while FAA charts show distances rounded to the nearest whole nautical mile.

Four trials had different questions for Jeppesen and FAA charts. Two questions were excluded from the analysis due to a spelling error. These questions are identified with an asterisk and appropriate text.

The approach practice questions are presented first, followed by the approach experiment questions. Then the departure practice questions are presented, with the departure experiment questions shown last.

Practice Approach Clearance	Practice Approach Question	Correct Answer (not scored)
You are cleared to DeKalb-Peachtree Airport (PDK) for RNAV (RNP) Z RWY 20L via WOMAC	What is the distance from FELOR to AABEE?	8.6
You are cleared to DeKalb-Peachtree Airport (PDK) for RNAV (RNP) Z RWY 20L via TUCKR	What is the airport elevation?	1003
You are cleared to DeKalb-Peachtree Airport (PDK) for RNAV (RNP) Z RWY 20L via MIKEE	What is the course from MIKEE to DODME?	52
You are cleared to DeKalb-Peachtree Airport (PDK) for RNAV (RNP) Z RWY 20L via BUNNI	What is the missed approach fix?	DODME
You are cleared to DeKalb-Peachtree Airport (PDK) for RNAV (RNP) Z RWY 20L via WOMAC	What is the final approach course?	203
You are cleared to DeKalb-Peachtree Airport (PDK) for RNAV (RNP) Z RWY 20L via TUCKR	What is the ground control frequency?	121.6

Experiment Approach Clearance	Experiment Approach Question	Correct Answer
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via EMETT	What is the distance from ZIZAZ to JADWI?	3.1
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via BANGS	What is the distance from JADWI to UNCOY?	1.9
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via RENOL	What is the track from DIKAC to CIPSA?	008
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via EREXE	What is the track from NEWKU to ROKTY?	260
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via PARMO	What is the maximum allowed speed at ELUMY?	180

Experiment Approach Clearance	Experiment Approach Question	Correct Answer
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via CADKI	What is the minimum altitude required from ZOVAM to HOBSI?	3900
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via CANEK	What is the minimum altitude required from SAKVY to CEPAV?	4300
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via UTEGE	What is the minimum altitude required from ZABEV to TAYFI?	9200
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via UTEGE **** More than one acceptable answer***	Other than GPS, what other equipment is required for procedure entry of UTEGE?	None RADAR RF
You are cleared for Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via BANGS	What is the missed approach hold fix?	JIMMI
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via CADKI ****Different questions for FAA & Jeppesen charts.***	FAA: What is the MSA?	9763
	Jeppesen: What is the length of the landing runway? **Answer outside of plan view.*	9400
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via BANGS **Answer outside of plan view.*	What is the ATIS frequency?	123.9
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via JOXIT	What is the distance from WOMET to the next waypoint?	10.4
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via WHITEHALL	What is the track from THESE to HUXAN?	92
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via LIVINGSTON	What is the maximum allowed speed at WINIX?	180
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via GODFE	What is the minimum altitude required from WOSAG to JURAL?	5600
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via JOXIT	What is the minimum RNP value required for procedure entry via JOXIT?	0.4
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via LIVINGSTON	What is the missed approach hold fix?	THESE

Experiment Approach Clearance	Experiment Approach Question	Correct Answer
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via WHITEHALL **Answer outside of plan view.*	What is the airport elevation?	4473
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via THESE **Answer outside of plan view.*	What is the ATIS frequency?	135.425
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via BALDI	What is the distance from BALDI to the next waypoint?	10
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via PALM SPRINGS	What is the track from PSP to HIXOV?	104
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via SBONO	What is the maximum allowed speed at SBONO?	210
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via CLOWD ****Excluded from analysis due to spelling error.***	What is the altitude constraint at WEMIR?	at or below 8000
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via PALM SPRINGS	What is the altitude constraint at HIXOV?	at or below 6500
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via TRM	What is the minimum RNP value required for procedure entry via TRM?	0.3
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via BALDI	What is the minimum climb gradient for missed approach to 3000 feet?	340
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via TRM	What is the final approach course?	309
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via UTEGE	What is the distance from MUFPI to JUBEN?	2
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via CADKI	What is the distance from ZOVAM to HOBSI?	1.4
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via BANGS	What is the track from LODZI to IBECO?	165
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via CANEK	What is the track from CANEK to OFTER?	314
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via RENOL	What is the allowed maximum speed at CIPSA?	180

Experiment Approach Clearance	Experiment Approach Question	Correct Answer
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via EREXE	What is the minimum altitude required from JUBEN to SAKVY?	4600
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via EMETT	What is the minimum altitude required from UNCOY to IDOCY?	4200
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via PARMO	What is the minimum altitude required from ELUMY to CIPSA?	5200
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via RENOL	This procedure is not available for arrivals at RENOL via which victor airway?	V113
You are cleared for Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via CANEK	What is the track from runway to missed approach point?	280
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via PARMO **Answer outside of plan view.*	What is the Airport Elevation?	2871
You are cleared to Boise Air Terminal (BOI) for the RNAV (RNP) Z RWY 28L via EMETT **Answer outside of plan view.*	What is Ground Control communication frequency?	121.7
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via LIVINGSTON	What is the distance from GATEY to the next waypoint?	7.2
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via GODFE	What is the track from ZIVTI to HUXAN?	157
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via JOXIT	What is the allowed maximum speed at TETBY?	180
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via WHITEHALL	What is the minimum altitude required from THESE to HUXAN?	7400
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via LIVINGSTON	What is the minimum RNP value required for procedure entry via LIVINGSTON?	0.4
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via GODFE	What is the missed approach track from HAXAG to THESE?	320
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via THESE **Answer outside of plan view.*	What is the TDZE?	4443

Experiment Approach Clearance	Experiment Approach Question	Correct Answer
You are cleared to Gallatin Field Airport (BZN) for the RNAV (RNP) Z RWY 12 via JOXIT **Answer outside of plan view.*	What is tower communication frequency?	118.2
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via PALMS SPRINGS	What is the distance from HIXOV to the next waypoint?	16.9
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via CLOWD	What is the track from RIYOC to TEVUC?	251
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via TRM	What is the maximum allowed speed at TRM?	210
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via SBONO ****Excluded from analysis due to spelling error.***	What is the altitude constraint at RIYOC?	At or below 5300
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Y RWY 31L via BALDI	What is the altitude constraint at CUPOL?	At or below 8000
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Z RWY 31L via PSP	What is the minimum RNP value required for procedure entry via PSP?	0.3
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Z RWY 31L via SBONO **Answer outside of plan view.*	What is the decision altitude for RNP 0.30?	734
You are cleared to Palm Springs Airport (PSP) for the RNAV (RNP) Z RWY 31L via CLOWD **Answer outside of plan view.*	What is the ATIS frequency?	118.25

Practice Departure Clearance	Practice Departure Question	Correct Answer (not scored)
You are cleared to depart from the Los Angeles International (LAX) via HOLTZ NINE departure via RWY 24R	What is the distance from FABRA to ENNEY?	Jeppesen: 1.8 FAA: 2
You are cleared to depart from the Los Angeles International (LAX) via HOLTZ NINE departure via RWY 24L	What is the altitude constraint at DLREY?	At or below 3000
You are cleared to depart from the Los Angeles International (LAX) via HOLTZ NINE departure via RWY 25R	What is the distance from DOCKR to WELIR?	Jeppesen: 2.2 FAA: 2

Practice Departure Clearance	Practice Departure Question	Correct Answer (not scored)
You are cleared to depart from the Los Angeles International (LAX) via HOLTZ NINE departure via RWY 24R	What is the SOCAL departure frequency?	124.3
You are cleared to depart from the Los Angeles International (LAX) via HOLTZ NINE departure via RWY 24R	What is the minimum climb gradient to 620ft?	500
You are cleared to depart from the Los Angeles International (LAX) via HOLTZ NINE departure via RWY 24R ***Answer not available on Jeppesen chart.***	What is the ATIS frequency?	FAA: 135.65

Experiment Departure Clearance	Experiment Departure Question	Correct Answer
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via MYTON	What is the distance from LOFOG to LEGBE?	Jeppesen: 45.8 FAA: 46
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via ROCK SPRINGS	What is the course from FEYOR to POPLE?	58
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via HOLTR	What is the speed restriction at MUCKI?	250
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via MEEKER	What is the altitude constraint at MURFI?	At or below FL230
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via HAYDEN	For non-GPS equipped aircraft, must the MLD DME be operational?	yes
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via MYTON via RWY 17 ***Different questions for FAA & Jeppesen charts.***	FAA: What is the Salt Lake City Tower Frequency?	118.3
	Jeppesen: What is the Salt Lake City Departure Frequency?	135.5
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via HAYDEN via RWY 16R	What is the minimum climb gradient required up to 9000'?	415
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via HOLTR	What is the altitude constraint at HUCKK?	At or above 12000

Experiment Departure Clearance	Experiment Departure Question	Correct Answer
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 19L	What is the distance from FIXIX TO ROPPR?	Jeppesen: 5.6 FAA: 6
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 7R	What is the track required from JESJI to BAKRR?	74
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 25R	What heading should you maintain after takeoff from Runway 25R?	255
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 7R	What is the ATC recommended altitude constraint at BAKRR?	At or below 7000
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 19R	For non-GPS equipped aircraft, must the LSV DME be operational?	yes
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 7L	What is the minimum climb gradient required after departing runway 7L?	400
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 25R	What is the departure frequency for your cleared runway?	125.9
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 25L	What is the altitude constraint at MDDOG?	9000
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 35C	What is the distance from OWLLS to SKTRR?	Jeppesen: 12.2 FAA: 12
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 36L	What is the track from KELLR to MYGAL?	171
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 18L	What is the speed constraint at LARRN?	At or below 240K
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 17C	What is the altitude constraint at TREXX?	At or above 5000
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 36L	For non-GPS equipped aircraft departing RWY 36L, must the CQY DME be operational?	yes

Experiment Departure Clearance	Experiment Departure Question	Correct Answer
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 35L	What is the Departure control frequency?	118.55
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 7L	What is the distance from MINEY to HITME?	12
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 25L	What is the track from PIRMD to ROPPR?	186
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 1L	What is the required maximum speed until BESSY?	At or below 230K
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 19R	What is the altitude window constraint at ROPPR?	At or above 6500 and at or below 7000
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 7R	For non-GPS equipped aircraft, must the LSV DME be operational?	no
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 25R	What is the minimum climb gradient required after departing runway 25R?	470
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure via RWY 19L ***Different questions for FAA & Jeppesen charts.***	FAA: What is the tower frequency for your cleared runway?	118.75
	Jepp: What is the airport elevation?	2181
You are cleared to depart from Las Vegas/McCarran International (LAS) via SHEAD SEVEN departure	What is the altitude constraint at TARRK?	11000
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via HOLTR	What is the distance from FRALL to SAWGI?	Jeppesen: 25.9 FAA: 26
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via MEEKER	What is the course form MURFI to UPJAR?	92
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via ROCK SPRINGS	What is the speed restriction at PLOGE?	250
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via HAYDEN	What is the altitude constraint at CHEDO?	At or below FL230

Experiment Departure Clearance	Experiment Departure Question	Correct Answer
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via MYTON	For non-GPS equipped aircraft, must the FFU DME be operational?	yes
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via ROCK SPRINGS via RWY 16L ****Different questions for FAA & Jeppesen charts.***	FAA: What is the GND Control Frequency?	133.65
	Jeppesen: What is the distance from SLC to PPIGG?	4
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via HOLTR via RWY 17	What is the minimum climb gradient required up to 9000?	370
You are cleared to depart from Salt Lake City (SLC) via LEETZ TWO departure via HOLTR	What is the altitude constraint at ZEETA?	At or below 10000
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 17R	What is the distance from TREX to DALBY?	7
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 18L	What is the track from LARRN to LIZIE?	175
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 35L	What is the speed constraint at MAVVS?	At or below 240K
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 36R	What is the altitude constraint at KMART?	At or above 5500
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 35C	What is the minimum climb gradient required for departure from Runway 35C?	536
You are cleared to depart from Dallas-Fort Worth (DFW) via DARTZ THREE departure via 18R	What is the Departure control frequency?	125.12

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Appendix C: Chart Images

All of the images tested in the study are presented in this appendix in half size. The charts for each airport are grouped, with FAA charts shown first and then Jeppesen charts. The order of charts within the airport set is given at the beginning of each set.

Dallas-Fort Worth DARTZ THREE

FAA

- Current text
- Current graphic

Modified

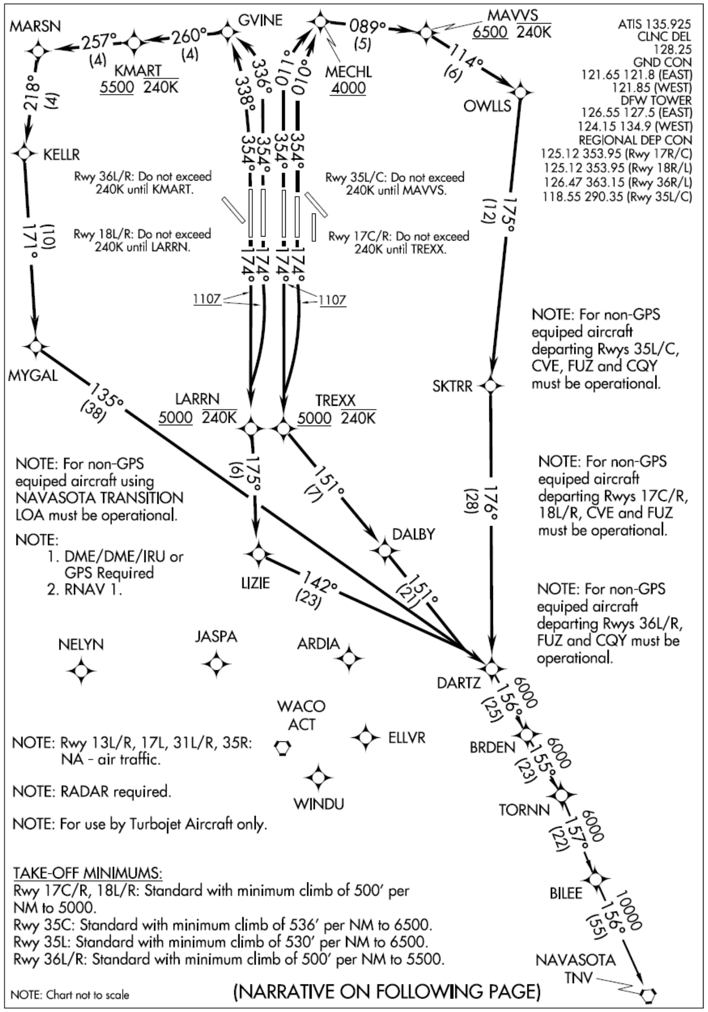
- 17C/R, 18L/R text
- 17C/R, 18L/R graphic
- 35L/C, 36 L/R text
- 35L/C, 36 L/R graphic

Jeppesen

- Current

Modified

- DFW: 17C/R, 18L/R
- DFW: 35L/C, 36 L/R



NOTE: For non-GPS equiped aircraft departing Rwys 35L/C, CVE, FUZ and CQY must be operational.

NOTE: For non-GPS equiped aircraft departing Rwys 17C/R, 18L/R, CVE and FUZ must be operational.

NOTE: For non-GPS equiped aircraft departing Rwys 36L/R, FUZ and CQY must be operational.

NOTE: For non-GPS equiped aircraft using NAVASOTA TRANSITION LOA must be operational.

NOTE:
1. DME/DME/IRU or GPS Required
2. RNAV 1.

NOTE: Rwy 13L/R, 17L, 31L/R, 35R: NA - air traffic.

NOTE: RADAR required.

NOTE: For use by Turbojet Aircraft only.

TAKE-OFF MINIMUMS:
Rwy 17C/R, 18L/R: Standard with minimum climb of 500' per NM to 5000.
Rwy 35C: Standard with minimum climb of 536' per NM to 6500.
Rwy 35L: Standard with minimum climb of 530' per NM to 6500.
Rwy 36L/R: Standard with minimum climb of 500' per NM to 5500.

NOTE: Chart not to scale

(NARRATIVE ON FOLLOWING PAGE)

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 17C: Climb heading 174° to 1107, then direct TREXX, cross TREXX at or above 5000, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 17R: Climb heading 174° to 1107, then direct TREXX, cross TREXX at or above 5000, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 18L: Climb heading 174° to 1107, then direct LARRN, cross LARRN at or above 5000, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 18R: Climb heading 174° to 1107, then direct LARRN, cross LARRN at or above 5000, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 35C: Climb heading 354° to intercept course 010° to MECHL, cross MECHL at or above 4000, then on track 089° to MAVVS, cross MAVVS at or above 6500, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 35L: Climb heading 354° to intercept course 011° to MECHL, cross MECHL at or above 4000, then on track 089° to MAVVS, cross MAVVS at or above 6500, then via depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 36L: Climb heading 354° to intercept course 338° to GVINE, then on track 260° to KMART, cross KMART at or above 5500, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 36R: Climb heading 354° to intercept course 336° to GVINE, then on track 260° to KMART, cross KMART at or above 5500, then on depicted route to DARTZ, Thence . . . .

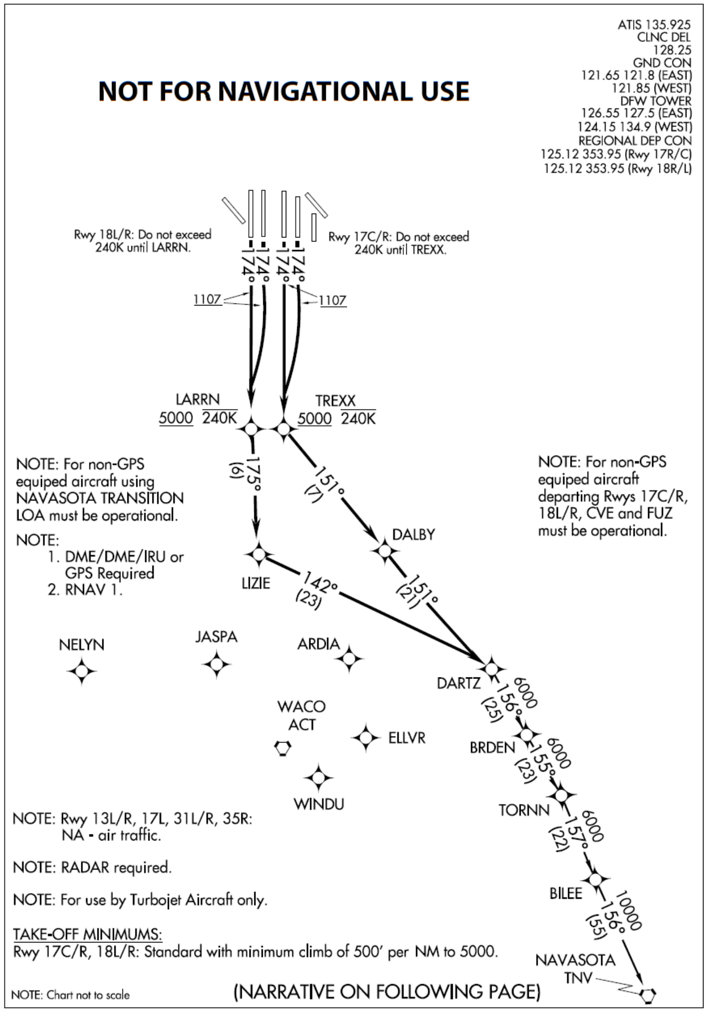
. . . . via (transition). Maintain 10,000. Expect filed altitude within 10 minutes after departure.

TORNN TRANSITION (DARTZ3.TORNN): (For aircraft landing Lafayette, Lake Charles or Beaumont/Port Arthur airports)

BILEE TRANSITION (DARTZ3.BILEE): (For aircraft overflying the Bilee intersection, thence on the appropriate STAR to George Bush Intercontinental or Eastern Houston terminal airports.)

NAVASOTA TRANSITION (DARTZ3.TNV)

(DARTZ3.DARTZ) 10098
DARTZ THREE DEPARTURE (RNAV)
(RWYS 17C/R, 18L/R)
DALLAS FORT WORTH INTL (DFW)
SL-6039 (FAA)
DALLAS-FORT WORTH, TEXAS



DARTZ THREE DEPARTURE (RNAV)
(RWYS 17C/R, 18L/R)
(DARTZ3.DARTZ) 10098
DALLAS-FORT WORTH, TEXAS
DALLAS FORT WORTH INTL (DFW)

SC-2, 10 MAR 2011 to 07 APR 2011

SC-2, 10 MAR 2011 to 07 APR 2011

SC-2, 10 MAR 2011 to 07 APR 2011

(DARTZ3.DARTZ) 10098
DARTZ THREE DEPARTURE (RNAV)
SL-6039 (FAA)
DALLAS-FORT WORTH INTL (DFW)
DALLAS-FORT WORTH, TEXAS

▼

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 17C: Climb heading 174° to 1107, then direct TREXX, cross TREXX at or above 5000, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 17R: Climb heading 174° to 1107, then direct TREXX, cross TREXX at or above 5000, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 18L: Climb heading 174° to 1107, then direct LARRN, cross LARRN at or above 5000, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 18R: Climb heading 174° to 1107, then direct LARRN, cross LARRN at or above 5000, then on depicted route to DARTZ. Thence . . . .

. . . . via (transition). Maintain 10,000. Expect filed altitude within 10 minutes after departure.

TORNN TRANSITION (DARTZ3.TORNN): (For aircraft landing Lafayette, Lake Charles or Beaumont/Port Arthur airports)

BILEE TRANSITION (DARTZ3.BILEE): (For aircraft overflying the Bilee intersection, thence on the appropriate STAR to George Bush Intercontinental or Eastern Houston terminal airports.)

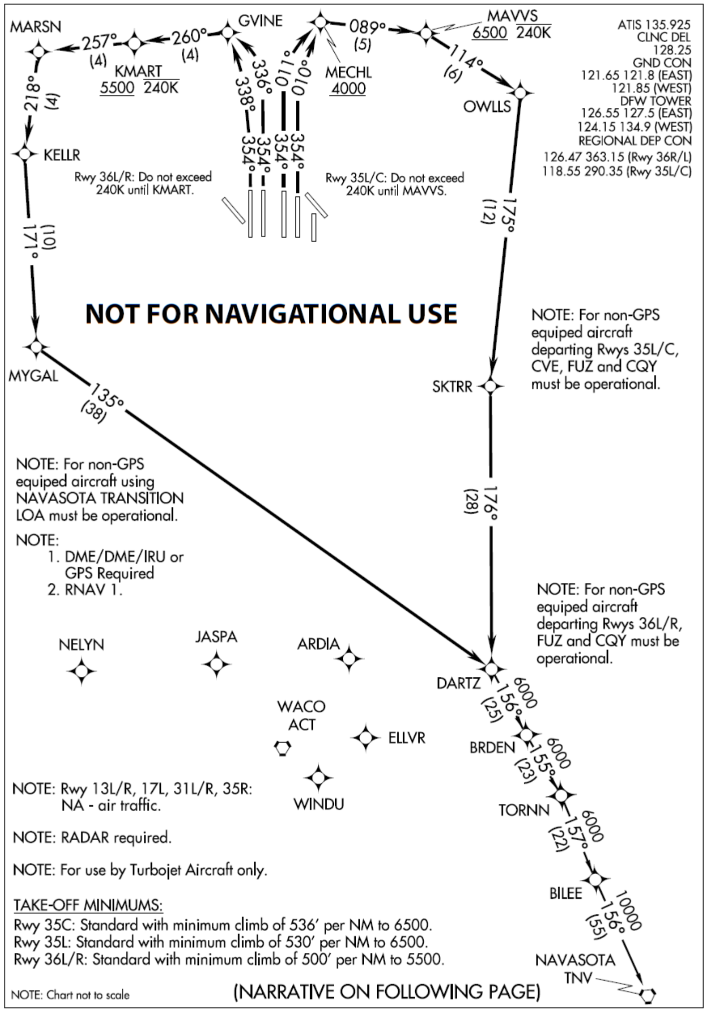
NAVASOTA TRANSITION (DARTZ3.TNV)

DARTZ THREE DEPARTURE (RNAV)
(DARTZ3.DARTZ) 10098
DALLAS-FORT WORTH, TEXAS
DALLAS-FORT WORTH INTL (DFW)

SC-2, 10 MAR 2011 to 07 APR 2011

(DARTZ3.DARTZ) 10098
DARTZ THREE DEPARTURE (RNAV)
(RWYS 35L/C, 36L/R)

DALLAS FORT WORTH INTL (DFW)
SL-6039 (FAA) DALLAS-FORT WORTH, TEXAS



DARTZ THREE DEPARTURE (RNAV)
(RWYS 35L/C, 36L/R)
(DARTZ3.DARTZ) 10098

DALLAS-FORT WORTH, TEXAS
DALLAS FORT WORTH INTL (DFW)

SC-2, 10 MAR 2011 to 07 APR 2011

SC-2, 10 MAR 2011 to 07 APR 2011

(DARTZ3.DARTZ) 10098 SL-6039 (FAA)
DARTZ THREE DEPARTURE (RNAV)

DALLAS-FORT WORTH INTL (DFW)
DALLAS-FORT WORTH, TEXAS

▼

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 35C: Climb heading 354° to intercept course 010° to MECHL, cross MECHL at or above 4000, then on track 089° to MAVVS, cross MAVVS at or above 6500, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 35L: Climb heading 354° to intercept course 011° to MECHL, cross MECHL at or above 4000, then on track 089° to MAVVS, cross MAVVS at or above 6500, then via depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 36L: Climb heading 354° to intercept course 338° to GVINE, then on track 260° to KMART, cross KMART at or above 5500, then on depicted route to DARTZ, Thence . . . .
TAKE-OFF RUNWAY 36R: Climb heading 354° to intercept course 336° to GVINE, then on track 260° to KMART, cross KMART at or above 5500, then on depicted route to DARTZ, Thence . . . .

. . . . via (transition). Maintain 10,000. Expect filed altitude within 10 minutes after departure.

TORNN TRANSITION (DARTZ3.TORNN): (For aircraft landing Lafayette, Lake Charles or Beaumont/Port Arthur airports)

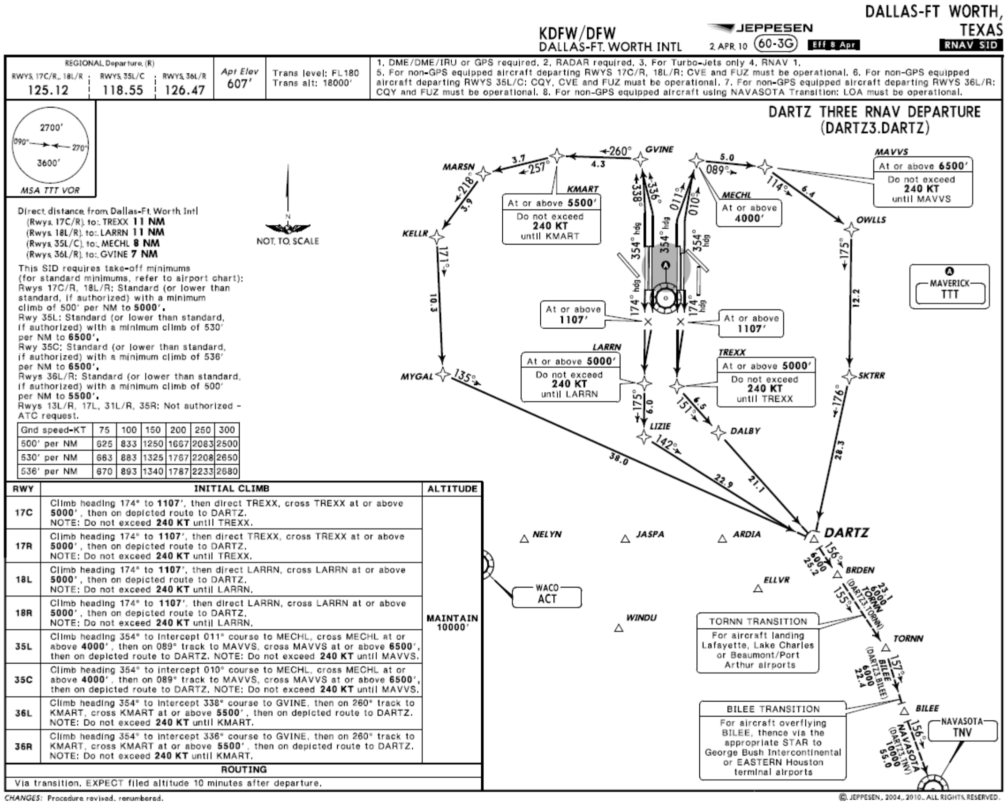
BILEE TRANSITION (DARTZ3.BILEE): (For aircraft overflying the Bilee intersection, thence on the appropriate STAR to George Bush Intercontinental or Eastern Houston terminal airports.)

NAVASOTA TRANSITION (DARTZ3.TNV)

DARTZ THREE DEPARTURE (RNAV)
(DARTZ3.DARTZ) 10098

DALLAS-FORT WORTH, TEXAS
DALLAS-FORT WORTH INTL (DFW)

SC-2, 10 MAR 2011 to 07 APR 2011


DALLAS-FT WORTH, TEXAS
KDFW/DFW
DALLAS-FT. WORTH INTL
JEPPESEN
2 APR 10 60-3G Eff 8 Apr
RNAV SID
REGIONAL Departure (R)
RWYS 17C/R, 18L/R 125.12
RWYS 35L/C 118.55
RWYS 36L/R 126.47
Apt Elev 607'
Trans level: FL180
Trans alt: 18000'
1. DME/DME/IRU or GPS required. 2. RADAR required. 3. For Turbo-Jets only 4. RNAV 1.
5. For non-GPS equipped aircraft departing RWYS 17C/R, 18L/R: CVE and FUZ must be operational. 6. For non-GPS equipped aircraft departing RWYS 35L/C: CQY, CVE and FUZ must be operational. 7. For non-GPS equipped aircraft departing RWYS 36L/R: CQY and FUZ must be operational. 8. For non-GPS equipped aircraft using NAVASOTA Transition: LOA must be operational.
DARTZ THREE RNAV DEPARTURE
(DARTZ3.DARTZ)
2700'
090°
270°
3600'
MSA TTT VOR
NOT TO SCALE
Direct distance from Dallas-Ft Worth Intl
(Rwys 17C/R) to: TREXX 11 NM
(Rwys 18L/R) to: LARRN 11 NM
(Rwys 35L/C) to: MECHL 8 NM
(Rwys 36L/R) to: GVINE 7 NM
This SID requires take-off minimums (for standard minimums, refer to airport chart):
Rwys 17C/R, 18L/R: Standard (or lower than standard, if authorized) with a minimum climb of 500' per NM to 5000'.
Rwy 35L: Standard (or lower than standard, if authorized) with a minimum climb of 530' per NM to 6500'.
Rwy 35C: Standard (or lower than standard, if authorized) with a minimum climb of 536' per NM to 6500'.
Rwys 36L/R: Standard (or lower than standard, if authorized) with a minimum climb of 500' per NM to 5500'.
Rwys 13L/R, 17L, 31L/R, 35R: Not authorized - ATC request.
Gnd speed-KT | 75 | 100 | 150 | 200 | 250 | 300
500' per NM | 625 | 833 | 1250 | 1667 | 2083 | 2500
530' per NM | 663 | 883 | 1325 | 1767 | 2208 | 2650
536' per NM | 670 | 893 | 1340 | 1787 | 2233 | 2680
RWY | INITIAL CLIMB | ALTITUDE
17C | Climb heading 174° to 1107', then direct TREXX, cross TREXX at or above 5000', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until TREXX. | MAINTAIN 10000'
17R | Climb heading 174° to 1107', then direct TREXX, cross TREXX at or above 5000', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until TREXX.
18L | Climb heading 174° to 1107', then direct LARRN, cross LARRN at or above 5000', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until LARRN.
18R | Climb heading 174° to 1107', then direct LARRN, cross LARRN at or above 5000', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until LARRN.
35L | Climb heading 354° to intercept 011° course to MECHL, cross MECHL at or above 4000', then on 089° track to MAVVS, cross MAVVS at or above 6500', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until MAVVS.
35C | Climb heading 354° to intercept 010° course to MECHL, cross MECHL at or above 4000', then on 089° track to MAVVS, cross MAVVS at or above 6500', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until MAVVS.
36L | Climb heading 354° to intercept 338° course to GVINE, then on 260° track to KMART, cross KMART at or above 5500', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until KMART.
36R | Climb heading 354° to intercept 336° course to GVINE, then on 260° track to KMART, cross KMART at or above 5500', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until KMART.
ROUTING
Via transition. EXPECT filed altitude 10 minutes after departure.
MARSN
KMART
At or above 5500'
Do not exceed 240 KT until KMART
GVINE
MECHL
At or above 4000'
MAVVS
At or above 6500'
Do not exceed 240 KT until MAVVS
OWLLS
KELLR
MAVERICK TTT
At or above 1107'
At or above 1107'
LARRN
At or above 5000'
Do not exceed 240 KT until LARRN
TREXX
At or above 5000'
Do not exceed 240 KT until TREXX
SKTRR
MYGAL
LIZIE
DALBY
DARTZ
NELYN
JASPA
ARDIA
BRDEN
ELLVR
WACO ACT
WINDU
TORNN TRANSITION
For aircraft landing Lafayette, Lake Charles or Beaumont/Port Arthur airports
TORNN
BILEE TRANSITION
For aircraft overflying BILEE, thence via the appropriate STAR to George Bush Intercontinental or EASTERN Houston terminal airports
BILEE
NAVASOTA TNV
CHANGES: Procedure revised, renumbered.
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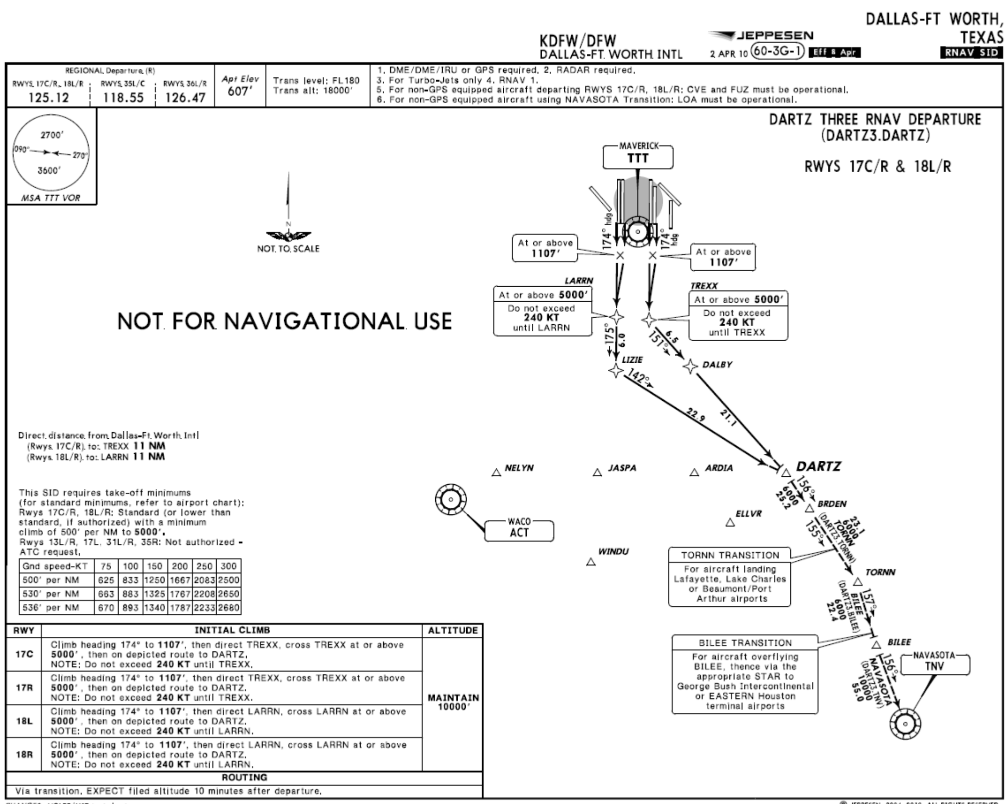
DALLAS-FT WORTH, TEXAS
KDFW/DFW
DALLAS-FT. WORTH INTL
JEPPESEN
2 APR 10 60-3G-1 Eff 8 Apr
RNAV SID
REGIONAL Departure (R)
RWYS 17C/R, 18L/R 125.12
RWYS 35L/C 118.55
RWYS 36L/R 126.47
Apt Elev 607'
Trans level: FL180
Trans alt: 18000'
1. DME/DME/IRU or GPS required. 2. RADAR required.
3. For Turbo-Jets only 4. RNAV 1.
5. For non-GPS equipped aircraft departing RWYS 17C/R, 18L/R: CVE and FUZ must be operational.
6. For non-GPS equipped aircraft using NAVASOTA Transition: LOA must be operational.
DARTZ THREE RNAV DEPARTURE
(DARTZ3.DARTZ)
RWYS 17C/R & 18L/R
2700'
090°
270°
3600'
MSA TTT VOR
NOT TO SCALE
NOT FOR NAVIGATIONAL USE
Direct distance from Dallas-Ft Worth Intl
(Rwys 17C/R) to: TREXX 11 NM
(Rwys 18L/R) to: LARRN 11 NM
This SID requires take-off minimums (for standard minimums, refer to airport chart):
Rwys 17C/R, 18L/R: Standard (or lower than standard, if authorized) with a minimum climb of 500' per NM to 5000'.
Rwys 13L/R, 17L, 31L/R, 35R: Not authorized - ATC request.
Gnd speed-KT | 75 | 100 | 150 | 200 | 250 | 300
500' per NM | 625 | 833 | 1250 | 1667 | 2083 | 2500
530' per NM | 663 | 883 | 1325 | 1767 | 2208 | 2650
536' per NM | 670 | 893 | 1340 | 1787 | 2233 | 2680
RWY | INITIAL CLIMB | ALTITUDE
17C | Climb heading 174° to 1107', then direct TREXX, cross TREXX at or above 5000', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until TREXX. | MAINTAIN 10000'
17R | Climb heading 174° to 1107', then direct TREXX, cross TREXX at or above 5000', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until TREXX.
18L | Climb heading 174° to 1107', then direct LARRN, cross LARRN at or above 5000', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until LARRN.
18R | Climb heading 174° to 1107', then direct LARRN, cross LARRN at or above 5000', then on depicted route to DARTZ. NOTE: Do not exceed 240 KT until LARRN.
ROUTING
Via transition. EXPECT filed altitude 10 minutes after departure.
MAVERICK TTT
At or above 1107'
At or above 1107'
LARRN
At or above 5000'
Do not exceed 240 KT until LARRN
TREXX
At or above 5000'
Do not exceed 240 KT until TREXX
LIZIE
DALBY
DARTZ
NELYN
JASPA
ARDIA
BRDEN
ELLVR
WACO ACT
WINDU
TORNN TRANSITION
For aircraft landing Lafayette, Lake Charles or Beaumont/Port Arthur airports
TORNN
BILEE TRANSITION
For aircraft overflying BILEE, thence via the appropriate STAR to George Bush Intercontinental or EASTERN Houston terminal airports
BILEE
NAVASOTA TNV
CHANGES: VOLPE/MIT test chart.
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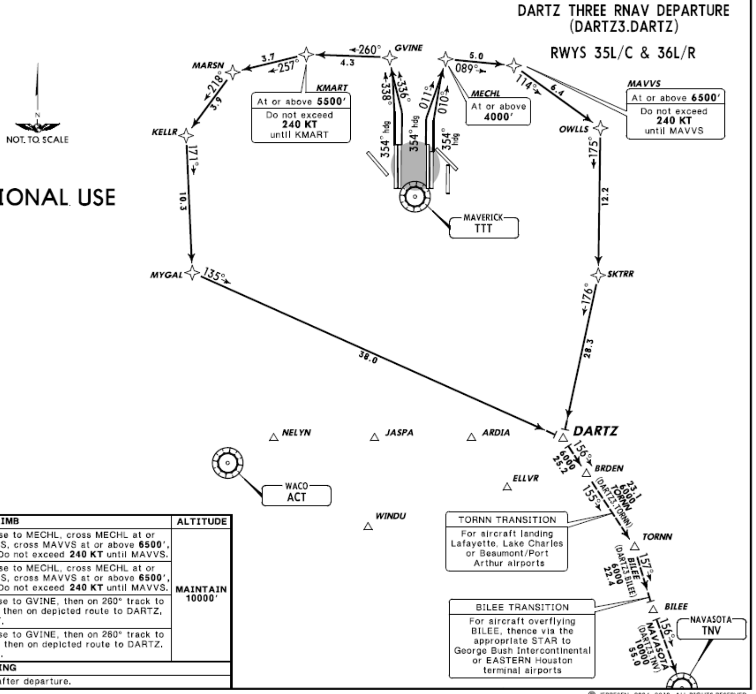
REGIONAL Departure (R) RWYS 17C/R, 18L/R	RWYS 35L/C	RWYS 36L/R	Apt Elev	Trans level / alt
125.12	118.55	126.47	607'	Trans level: FL180 Trans alt: 18000'

1. DME/DME/IRU or GPS required. 2. RADAR required. 3. For Turbo-Jets only 4. RNAV 1.
5. For non-GPS equipped aircraft departing RWYS 35L/C: CQY, CVE and FUZ must be operational.
6. For non-GPS equipped aircraft departing RWYS 36L/R: CQY and FUZ must be operational.
7. For non-GPS equipped aircraft using NAVASOTA Transition: LOA must be operational.

2700'
090°
270°
3600'
MSA TTT VOR

DARTZ THREE RNAV DEPARTURE (DARTZ3.DARTZ)

RWYS 35L/C & 36L/R



NOT FOR NAVIGATIONAL USE

Direct distance from Dallas-Ft. Worth Intl
(Rwys. 35L/C) to: MECHL **8 NM**
(Rwys. 36L/R) to: GVINE **7 NM**

This SID requires take-off minimums
(for standard minimums, refer to airport chart):
Rwy 35L: Standard (or lower than standard, if authorized) with a minimum climb of 530' per NM to **6500'**.
Rwy 35C: Standard (or lower than standard, if authorized) with a minimum climb of 536' per NM to **6500'**.
Rwys 36L/R: Standard (or lower than standard, if authorized) with a minimum climb of 500' per NM to **5500'**.

Gnd speed-KT	75	100	150	200	250	300
500' per NM	625	833	1250	1667	2083	2500
530' per NM	663	883	1325	1767	2208	2650
536' per NM	670	893	1340	1787	2233	2680

RWY	INITIAL CLIMB	ALTITUDE
35L	Climb heading 354° to intercept 011° course to MECHL, cross MECHL at or above **4000'**, then on 089° track to MAVVS, cross MAVVS at or above **6500'**, then on depicted route to DARTZ. NOTE: Do not exceed **240 KT** until MAVVS.	**MAINTAIN 10000'**
35C	Climb heading 354° to intercept 010° course to MECHL, cross MECHL at or above **4000'**, then on 089° track to MAVVS, cross MAVVS at or above **6500'**, then on depicted route to DARTZ. NOTE: Do not exceed **240 KT** until MAVVS.	
36L	Climb heading 354° to intercept 338° course to GVINE, then on 260° track to KMART, cross KMART at or above **5500'**, then on depicted route to DARTZ. NOTE: Do not exceed **240 KT** until KMART.	
36R	Climb heading 354° to intercept 336° course to GVINE, then on 260° track to KMART, cross KMART at or above **5500'**, then on depicted route to DARTZ. NOTE: Do not exceed **240 KT** until KMART.	

ROUTING

Via transition. EXPECT filed altitude 10 minutes after departure.

CHANGES: VOLPE/MIT test chart.

Las Vegas SHEAD SEVEN

FAA

- Current text
- Current graphic

Modified

- RWYS 1L/R, 19L/R text
- RWYS 1L/R, 19L/R graphic
- RWYS 7L/R, 25L/R text
- RWYS 7L/R, 25L/R graphic

Jeppesen

- Current

Modified

- RWYS 1L/R, 19L/R
- RWYS 7L/R, 25L/R

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 1L/R: Climb heading 010° to 2681′, then left turn direct BESSY, then on track 188° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 7L: Climb heading 075° to 2681′, then direct WASTE, then on track 075° to cross BAKRR at or below 7000(ATC)/6000, then on track 144° to cross MINEY at or above 8000, then on track 210° to HITME, then on track 261° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 7R: Climb heading 075° to 2681′, then direct JESJI, then on track 074° to cross BAKRR at or below 7000(ATC)/6000, then on track 144° to cross MINEY at or above 8000, then on track 210° to HITME, then on track 261° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 19L: Climb heading 190° to 2681′, then direct FIXIX, then on track 227° to cross ROPPR at or below 7000(ATC)/6500, then on track 210° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 19R: Climb heading 190° to 2681′, then direct JAKER, then on track 226° to cross ROPPR at or below 7000(ATC)/6500, then on track 210° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 25L: Climb heading 255° to 2681′, then direct PIRMD, then on track 186° to cross ROPPR at or below 7000(ATC)/6500, then on track 210° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 25R: Climb heading 255° to 2681′, then direct RBELL, then on track 186° to cross ROPPR at or below 7000(ATC)/6500, then on track 210° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

....via (Transition) maintain FL190, expect filed altitude 10 minutes after departure.

COALDALE TRANSITION (SHEAD7.OAL)

KENNO TRANSITION (SHEAD7.KENNO)

TAKE-OFF OBSTACLE NOTES

RWY 1L: Building 1508′ from DER, 463′ left of centerline, 71′ AGL/2146′ MSL. Pole 453′ from DER, 283′ left of centerline, 38′ AGL/2118′ MSL. Sign 1042′ from DER, 694′ left of centerline, 35′ AGL/2124′ MSL.

RWY 1R: Sign 1331′ from DER, 448′ right of centerline, 60′ AGL/2120′ MSL.
Vents 604′ from DER, 539′ right of centerline, up to 17′ AGL/2095′ MSL.

RWY 7L: Trees 761′ from DER, left and right of centerline, up to 42′ AGL/2074′ MSL.
Pole 747′ from DER, 442′ right of centerline, 25′ AGL/2057′ MSL.

RWY 7R: Tower 1457′ from DER, 847′ right of centerline, 65′ AGL/2096′ MSL.

RWY 19L: Multiple buildings, trees and poles 1394′ from DER, 251′ right of centerline, up to 96′ AGL/2284′ MSL. Sign 2181′ from DER, 1062′ right of centerline, 36′ AGL/2236′ MSL.

RWY 19R: Trees 1563′ from DER, 329′ left of centerline, up to 55′ AGL/2236′ MSL.
Multiple buildings, signs and poles 197′ from DER, 59′ right of centerline, up to 75′ AGL/2291′ MSL.

RWY 25L: Multiple poles, signs and buildings 1003′ from DER, 145′ left of centerline, up to 97′ AGL/2291′ MSL. Trees 2837′ from DER, 1008′ left of centerline, 72′ AGL/2230′ MSL.
Railroad 2564′ from DER, 773′ left of centerline, 66′ AGL/2223′ MSL.

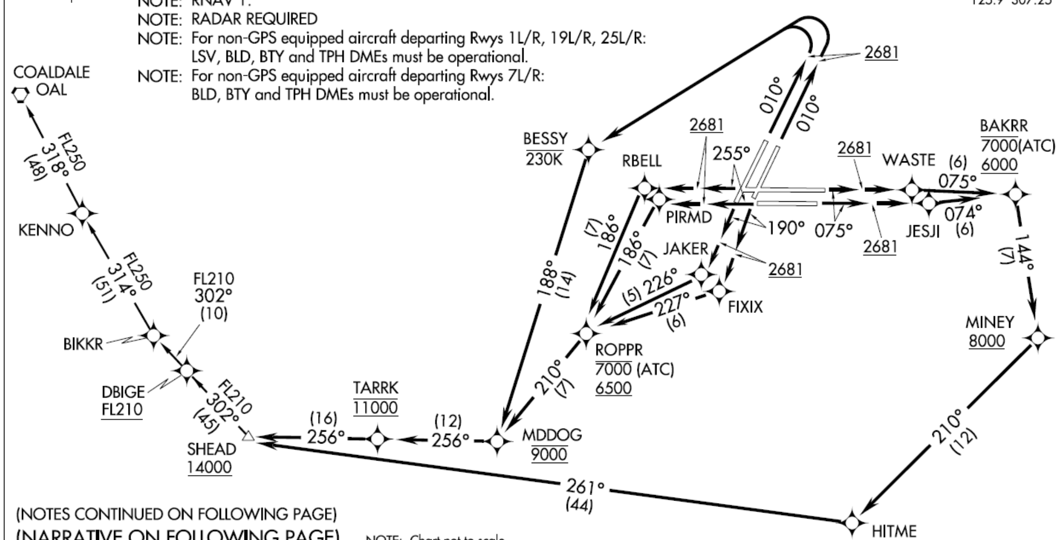
RWY 25R: Multiple poles and trees 533′ from DER, 1′ left of centerline, up to 271′ AGL/2457′ MSL.
Building 1822′ from DER, 652′ left of centerline, 59′ AGL/2238′ MSL. Roads 669′ from DER, 17′ right of centerline, up to 29′ AGL/2208′ MSL.

ATIS 132.4
CLNC DEL 118.0 379.95
GND CON 121.1 270.8 E of 1R/19L
121.9 254.3 W of 1R/19L
LAS VEGAS TOWER 118.75 257.8 (Rwy 1L/19R, 1R/19L)
119.9 257.8 (Rwy 7L/25R, 7R/25L)
LAS VEGAS DEP CON 125.9 307.25

TAKE-OFF MINIMUMS

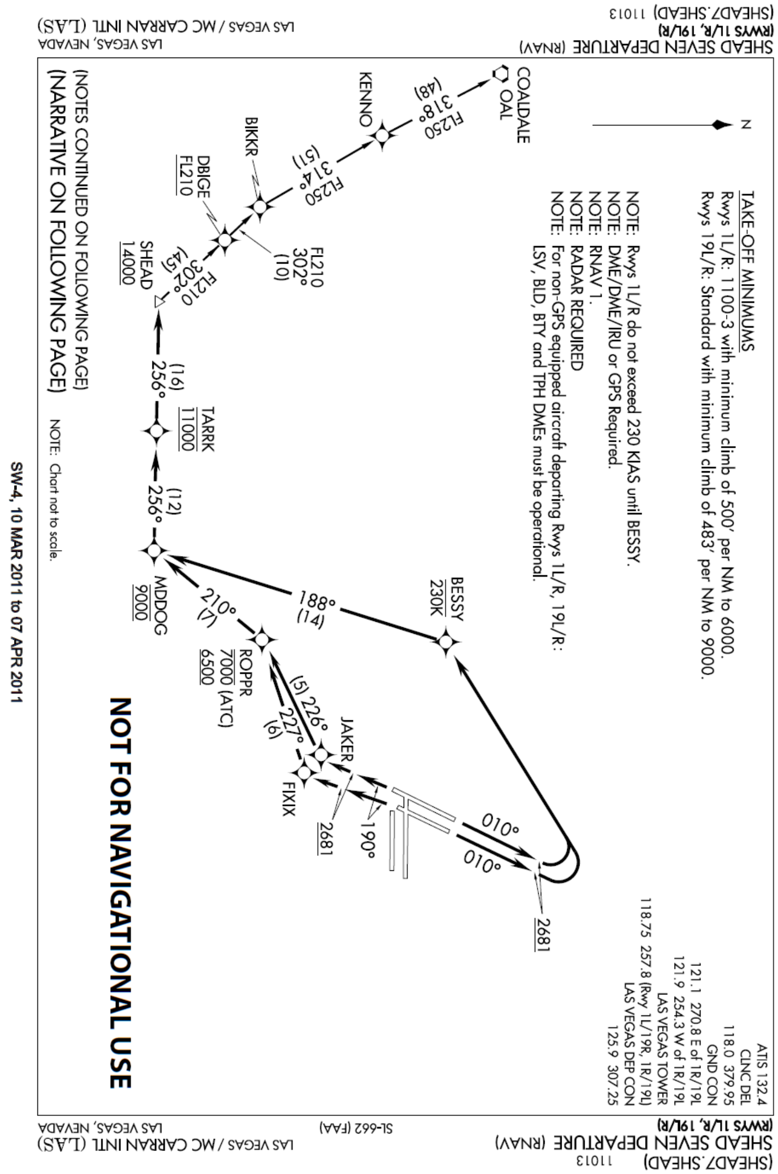
Rwys 1L/R: 1100-3 with minimum climb of 500′ per NM to 6000.
Rwys 7L/R: Standard with minimum climb of 400′ per NM to 8000.
Rwys 19L/R: Standard with minimum climb of 483′ per NM to 9000.
Rwys 25L/R: Standard with minimum climb of 470′ per NM to 9000.

NOTE: Rwys 1L/R do not exceed 230 KIAS until BESSY.
NOTE: DME/DME/IRU or GPS Required.
NOTE: RNAV 1.
NOTE: RADAR REQUIRED
NOTE: For non-GPS equipped aircraft departing Rwys 1L/R, 19L/R, 25L/R: LSV, BLD, BTY and TPH DMEs must be operational.
NOTE: For non-GPS equipped aircraft departing Rwys 7L/R: BLD, BTY and TPH DMEs must be operational.



(NOTES CONTINUED ON FOLLOWING PAGE)
(NARRATIVE ON FOLLOWING PAGE)

NOTE: Chart not to scale.



DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 1L/R: Climb heading 010° to 2681', then left turn direct BESSY, then on track 188° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 19L: Climb heading 190° to 2681', then direct FIXIX, then on track 227° to cross ROPPR at or below 7000(ATC)/6500, then on track 210° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 19R: Climb heading 190° to 2681', then direct JAKER, then on track 226° to cross ROPPR at or below 7000(ATC)/6500, then on track 210° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

....via (Transition) maintain FL190, expect filed altitude 10 minutes after departure.

COALDALE TRANSITION (SHEAD7.OAL)

KENNO TRANSITION (SHEAD7.KENNO)

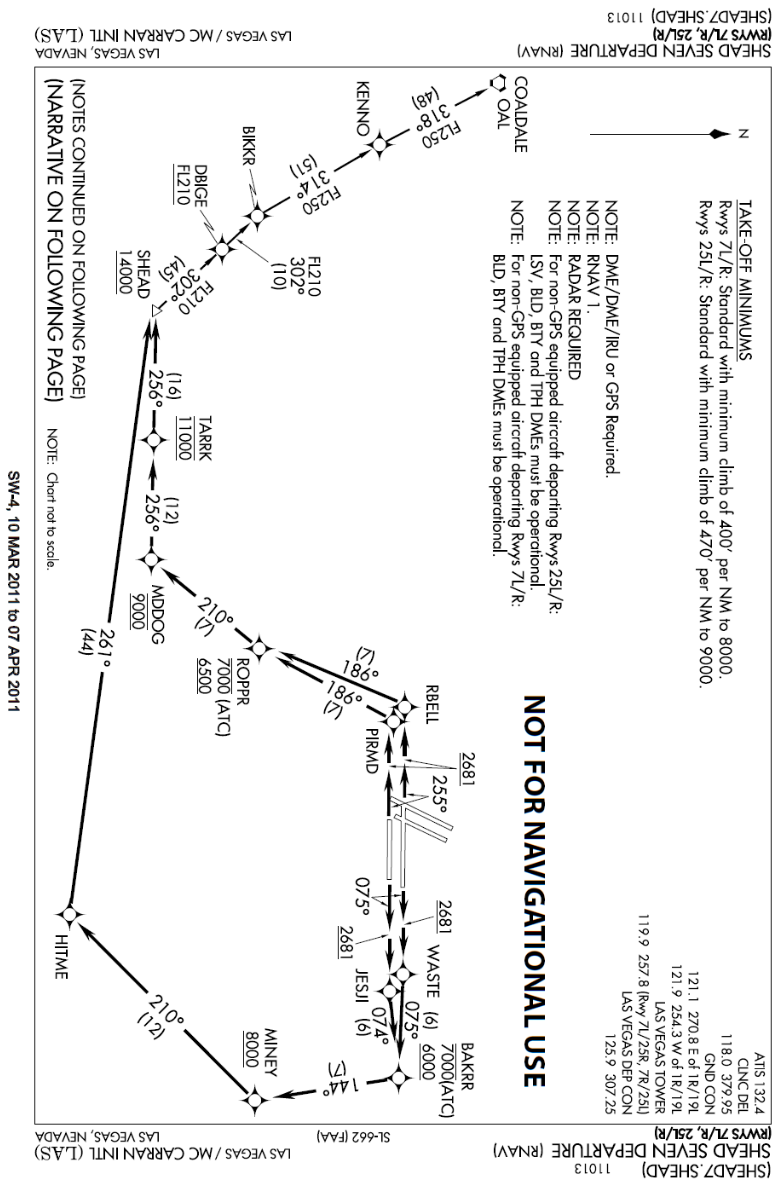
TAKE-OFF OBSTACLE NOTES

RWY 1L: Building 1508' from DER, 463' left of centerline, 71' AGL/2146' MSL. Pole 453' from DER, 283' left of centerline, 38' AGL/2118' MSL. Sign 1042' from DER, 694' left of centerline, 35' AGL/2124' MSL.

RWY 1R: Sign 1331' from DER, 448' right of centerline, 60' AGL/2120' MSL. Vents 604' from DER, 539' right of centerline, up to 17' AGL/2095' MSL.

RWY 19L: Multiple buildings, trees and poles 1394' from DER, 251' right of centerline, up to 96' AGL/2284' MSL. Sign 2181' from DER, 1062' right of centerline, 36' AGL/2236' MSL.

RWY 19R: Trees 1563' from DER, 329' left of centerline, up to 55' AGL/2236' MSL. Multiple buildings, signs and poles 197' from DER, 59' right of centerline, up to 75' AGL/2291' MSL.



(SHEAD7.SHEAD) 11013

SHEAD SEVEN DEPARTURE (RNAV) SL-662 (FAA)

LAS VEGAS / MC CARRAN INTL (LAS)
LAS VEGAS, NEVADA

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAY 7L: Climb heading 075° to 2681', then direct WASTE, then on track 075° to cross BAKRR at or below 7000(ATC)/6000, then on track 144° to cross MINEY at or above 8000, then on track 210° to HITME, then on track 261° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 7R: Climb heading 075° to 2681', then direct JESJI, then on track 074° to cross BAKRR at or below 7000(ATC)/6000, then on track 144° to cross MINEY at or above 8000, then on track 210° to HITME, then on track 261° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 25L: Climb heading 255° to 2681', then direct PIRMD, then on track 186° to cross ROPPR at or below 7000(ATC)/6500, then on track 210° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

TAKE-OFF RUNWAY 25R: Climb heading 255° to 2681', then direct RBELL, then on track 186° to cross ROPPR at or below 7000(ATC)/6500, then on track 210° to cross MDDOG at 9000, then on track 256° to cross TARRK at 11000, then on track 256° to cross SHEAD at or above 14000. Thence....

....via (Transition) maintain FL190, expect filed altitude 10 minutes after departure.

COALDALE TRANSITION (SHEAD7.OAL)

KENNO TRANSITION (SHEAD7.KENNO)

TAKE-OFF OBSTACLE NOTES

RWY 7L: Trees 761' from DER, left and right of centerline, up to 42' AGL/2074' MSL.
Pole 747' from DER, 442' right of centerline, 25' AGL/2057' MSL.

RWY 7R: Tower 1457' from DER, 847' right of centerline, 65' AGL/2096' MSL.

RWY 25L: Multiple poles, signs and buildings 1003' from DER, 145' left of centerline, up to 97' AGL/2291' MSL. Trees 2837' from DER, 1008' left of centerline, 72' AGL/2230' MSL. Railroad 2564' from DER, 773' left of centerline, 66' AGL/2223' MSL.

RWY 25R: Multiple poles and trees 533' from DER, 1' left of centerline, up to 271' AGL/2457' MSL. Building 1822' from DER, 652' left of centerline, 59' AGL/2238' MSL. Roads 669' from DER, 17' right of centerline, up to 29' AGL/2208' MSL.

SHEAD SEVEN DEPARTURE (RNAV)
(SHEAD7.SHEAD) 11013
LAS VEGAS, NEVADA
LAS VEGAS / MC CARRAN INTL (LAS)

SW-4, 10 MAR 2011 to 07 APR 2011

KLAS/LAS
McCARRAN INTL

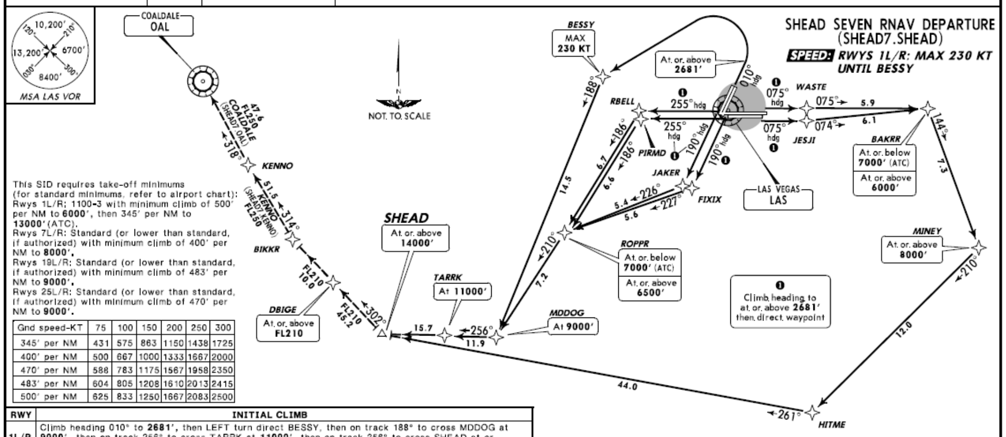
JEPPESEN
18 MAR 11 (10-3F)

LAS VEGAS, NEV
RNAV SID

LAS VEGAS Departure (R)	Apt Elev		
125.9	2181′	Trans level: FL180 Trans alt: 18000′	**1. DME/DME/IRU or GPS required.** **2. RNAV 1.** **3. RADAR required.** 4. For non-GPS equipped aircraft departing Rwys 1L/R, 19L/R, 25L/R: LSV, BLD, BTY and TPH DMEs must be operational. 5. For non-GPS equipped aircraft departing Rwys 7L/R: BLD, BTY and TPH DMEs must be operational.

SHEAD SEVEN RNAV DEPARTURE (SHEAD7.SHEAD)

SPEED: RWYS 1L/R: MAX 230 KT UNTIL BESSY



This SID requires take-off minimums (for standard minimums, refer to airport chart):
Rwys 1L/R: 1100-3 with minimum climb of 500′ per NM to **6000′**, then 345′ per NM to **13000′**(ATC).
Rwys 7L/R: Standard (or lower than standard, if authorized) with minimum climb of 400′ per NM to **8000′**.
Rwys 19L/R: Standard (or lower than standard, if authorized) with minimum climb of 483′ per NM to **9000′**.
Rwys 25L/R: Standard (or lower than standard, if authorized) with minimum climb of 470′ per NM to **9000′**.

Gnd speed-KT	75	100	150	200	250	300
345′ per NM	431	575	863	1150	1438	1725
400′ per NM	500	667	1000	1333	1667	2000
470′ per NM	588	783	1175	1567	1958	2350
483′ per NM	604	805	1208	1610	2013	2415
500′ per NM	625	833	1250	1667	2083	2500

RWY	INITIAL CLIMB
1L/R	Climb heading 010° to **2681′**, then LEFT turn direct BESSY, then on track 188° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.
7L	Climb heading 075° to **2681′**, then direct WASTE, then on track 075° to cross BAKRR at or below **7000′**(ATC)/at or above **6000′**, then on track 144° to cross MINEY at or above **8000′**, then on track 210° to HITME, then on track 261° to cross SHEAD at or above **14000′**.
7R	Climb heading 075° to **2681′**, then direct JESJI, then on track 074° to cross BAKRR at or below **7000′**(ATC)/at or above **6000′**, then on track 144° to cross MINEY at or above **8000′**, then on track 210° to HITME, then on track 261° to cross SHEAD at or above **14000′**.
19L	Climb heading 190° to **2681′**, then direct FIXIX, then on track 227° to cross ROPPR at or below **7000′** (ATC)/at or above **6500′**, then on track 210° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.
19R	Climb heading 190° to **2681′**, then direct JAKER, then on track 226° to cross ROPPR at or below **7000′** (ATC)/at or above **6500′**, then on track 210° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.
25L	Climb heading 255° to **2681′**, then direct PIRMD, then on track 186° to cross ROPPR at or below **7000′** (ATC)/at or above **6500′**, then on track 210° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.
25R	Climb heading 255° to **2681′**, then direct RBELL, then on track 186° to cross ROPPR at or below **7000′** (ATC)/at or above **6500′**, then on track 210° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.

ROUTING	ALTITUDE
From SHEAD via transition. EXPECT filed altitude 10 minutes after departure.	**MAINTAIN FL190**

Direct distance from McCarran Intl
(Rwys. 1L/R), to: BESSY **7 NM**
(Rwy. 7L), to: WASTE **4 NM**
(Rwy. 7R), to: JESJI **4 NM**
(Rwy. 19L), to: FIXIX **5 NM**
(Rwy. 19R), to: JAKER **5 NM**
(Rwy. 25L), to: PIRMD **5 NM**
(Rwy. 25R), to: RBELL **5 NM**

OBSTACLES
Rwy 1L: Building 1508′ from DER, 463′ LEFT of centerline, 71′ AGL/2146′ MSL. Pole 453′ from DER, 283′ LEFT of centerline, 38′ AGL/2118′ MSL. Sign 1042′ from DER, 694′ LEFT of centerline, 35′ AGL/2124′ MSL.
Rwy 1R: Sign 1331′ from DER, 448′ RIGHT of centerline, 60′ AGL/2120′ MSL. Vents 604′ from DER, 539′ RIGHT of centerline, up to 17′ AGL/2095′ MSL.
Rwy 7L: Trees 761′ from DER, LEFT and RIGHT of centerline, up to 42′ AGL/2074′ MSL. Pole 747′ from DER, 442′ RIGHT of centerline, 25′ AGL/2057′ MSL.
Rwy 7R: Tower 1457′ from DER, 847′ RIGHT of centerline, 65′ AGL/2096′ MSL.
Rwy 19L: Multiple buildings, trees and poles 1394′ from DER, 251′ RIGHT of centerline, up to 96′ AGL/2284′ MSL. Sign 2181′ from DER, 1062′ RIGHT of centerline, 36′ AGL/2236′ MSL.
Rwy 19R: Trees 1563′ from DER, 329′ LEFT of centerline, up to 55′ AGL/2236′ MSL. Multiple buildings, signs and poles 197′ from DER, 59′ RIGHT of centerline, up to 75′ AGL/2291′ MSL.
Rwy 25L: Multiple poles, sign and buildings 1003′ from DER, 145′ LEFT of centerline, up to 97′ AGL/2291′ MSL. Tree 2837′ from DER, 1008′ LEFT of centerline, 72′ AGL/2230′ MSL. Railroad 2564′ from DER, 773′ LEFT of centerline, 66′ AGL/2223′ MSL.
Rwy 25R: Multiple poles and trees 533′ from DER, 1′ LEFT of centerline, up to 271′ AGL/2457′ MSL. Building 1822′ from DER, 652′ LEFT of centerline, 59′ AGL/2238′ MSL. Roads 669′ from DER, 17′ RIGHT of centerline, up to 29′ AGL/2208′ MSL.

CHANGES: None.

KLAS/LAS
McCARRAN INTL

JEPPESEN
18 MAR 11 (10-3F-1)

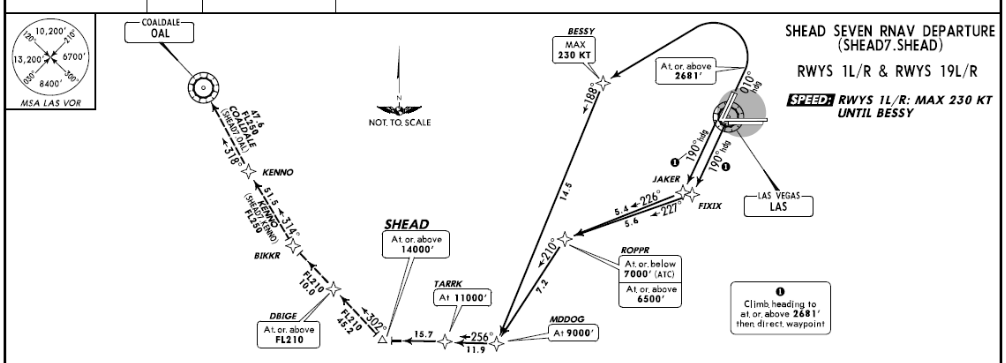
LAS VEGAS, NEV
RNAV SID

LAS VEGAS Departure (R)	Apt Elev		
125.9	2181′	Trans level: FL180 Trans alt: 18000′	**1. DME/DME/IRU or GPS required.** **2. RNAV 1.** **3. RADAR required.** 4. For non-GPS equipped aircraft departing Rwys 1L/R, 19L/R: LSV, BLD, BTY and TPH DMEs must be operational.

SHEAD SEVEN RNAV DEPARTURE (SHEAD7.SHEAD)

RWYS 1L/R & RWYS 19L/R

SPEED: RWYS 1L/R: MAX 230 KT UNTIL BESSY



This SID requires take-off minimums (for standard minimums, refer to airport chart):
Rwys 1L/R: 1100-3 with minimum climb of 500′ per NM to **6000′**, then 345′ per NM to **13000′**(ATC).
Rwys 19L/R: Standard (or lower than standard, if authorized) with minimum climb of 483′ per NM to **9000′**.

NOT FOR NAVIGATIONAL USE

Gnd speed-KT	75	100	150	200	250	300
345′ per NM	431	575	863	1150	1438	1725
400′ per NM	500	667	1000	1333	1667	2000
470′ per NM	588	783	1175	1567	1958	2350
483′ per NM	604	805	1208	1610	2013	2415
500′ per NM	625	833	1250	1667	2083	2500

Direct distance from McCarran Intl
(Rwys. 1L/R), to: BESSY **7 NM**
(Rwy. 19L), to: FIXIX **5 NM**
(Rwy. 19R), to: JAKER **5 NM**

RWY	INITIAL CLIMB
1L/R	Climb heading 010° to **2681′**, then LEFT turn direct BESSY, then on track 188° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.
19L	Climb heading 190° to **2681′**, then direct FIXIX, then on track 227° to cross ROPPR at or below **7000′** (ATC)/at or above **6500′**, then on track 210° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.
19R	Climb heading 190° to **2681′**, then direct JAKER, then on track 226° to cross ROPPR at or below **7000′** (ATC)/at or above **6500′**, then on track 210° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.

ROUTING	ALTITUDE
From SHEAD via transition. EXPECT filed altitude 10 minutes after departure.	**MAINTAIN FL190**

OBSTACLES
Rwy 1L: Building 1508′ from DER, 463′ LEFT of centerline, 71′ AGL/2146′ MSL. Pole 453′ from DER, 283′ LEFT of centerline, 38′ AGL/2118′ MSL. Sign 1042′ from DER, 694′ LEFT of centerline, 35′ AGL/2124′ MSL.
Rwy 1R: Sign 1331′ from DER, 448′ RIGHT of centerline, 60′ AGL/2120′ MSL. Vents 604′ from DER, 539′ RIGHT of centerline, up to 17′ AGL/2095′ MSL.
Rwy 19L: Multiple buildings, trees and poles 1394′ from DER, 251′ RIGHT of centerline, up to 96′ AGL/2284′ MSL. Sign 2181′ from DER, 1062′ RIGHT of centerline, 36′ AGL/2236′ MSL.
Rwy 19R: Trees 1563′ from DER, 329′ LEFT of centerline, up to 55′ AGL/2236′ MSL. Multiple buildings, signs and poles 197′ from DER, 59′ RIGHT of centerline, up to 75′ AGL/2291′ MSL.

CHANGES: VOLPE/MIT test chart.

KLAS/LAS
McCARRAN INTL

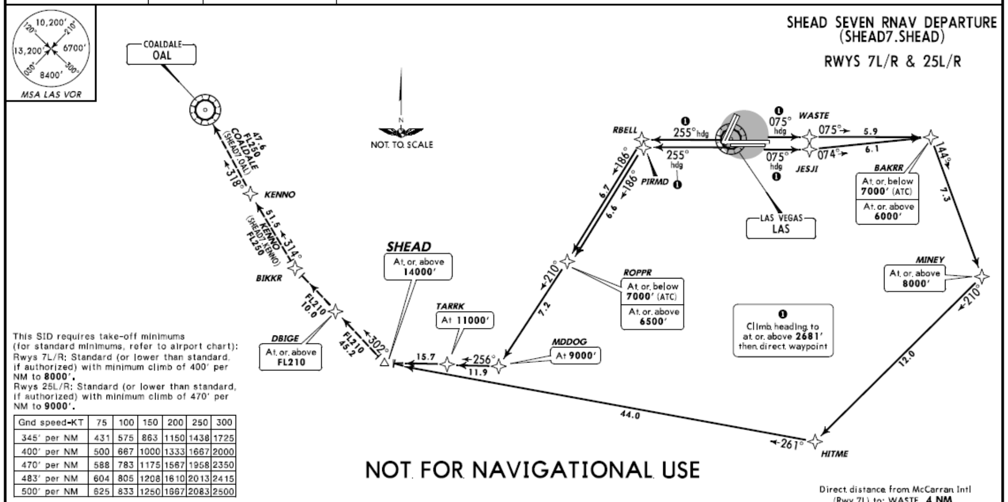
JEPPESEN
18 MAR 11 (10-3F-2)

LAS VEGAS, NEV
RNAV SID

LAS VEGAS Departure (R)	Apt Elev		
125.9	2181′	Trans level: FL180 Trans alt: 18000′	**1. DME/DME/IRU or GPS required.** **2. RNAV 1.** **3. RADAR required.** 4. For non-GPS equipped aircraft departing Rwys 25L/R: LSV, BLD, BTY and TPH DMEs must be operational. 5. For non-GPS equipped aircraft departing Rwys 7L/R: BLD, BTY and TPH DMEs must be operational.

SHEAD SEVEN RNAV DEPARTURE (SHEAD7.SHEAD)

RWYS 7L/R & 25L/R



This SID requires take-off minimums (for standard minimums, refer to airport chart):
Rwys 7L/R: Standard (or lower than standard, if authorized) with minimum climb of 400′ per NM to **8000′**.
Rwys 25L/R: Standard (or lower than standard, if authorized) with minimum climb of 470′ per NM to **9000′**.

Gnd speed-KT	75	100	150	200	250	300
345′ per NM	431	575	863	1150	1438	1725
400′ per NM	500	667	1000	1333	1667	2000
470′ per NM	588	783	1175	1567	1958	2350
483′ per NM	604	805	1208	1610	2013	2415
500′ per NM	625	833	1250	1667	2083	2500

Direct distance from McCarran Intl
(Rwy 7L) to: WASTE **4 NM**
(Rwy 7R) to: JESJI **4 NM**
(Rwy 25L) to: PIRMD **5 NM**
(Rwy 25R) to: RBELL **5 NM**

RWY	INITIAL CLIMB
7L	Climb heading 075° to **2681′**, then direct WASTE, then on track 075° to cross BAKRR at or below **7000′**(ATC)/at or above **6000′**, then on track 144° to cross MINEY at or above **8000′**, then on track 210° to HITME, then on track 261° to cross SHEAD at or above **14000′**.
7R	Climb heading 075° to **2681′**, then direct JESJI, then on track 074° to cross BAKRR at or below **7000′**(ATC)/at or above **6000′**, then on track 144° to cross MINEY at or above **8000′**, then on track 210° to HITME, then on track 261° to cross SHEAD at or above **14000′**.
25L	Climb heading 255° to **2681′**, then direct PIRMD, then on track 186° to cross ROPPR at or below **7000′** (ATC)/at or above **6500′**, then on track 210° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.
25R	Climb heading 255° to **2681′**, then direct RBELL, then on track 186° to cross ROPPR at or below **7000′** (ATC)/at or above **6500′**, then on track 210° to cross MDDOG at **9000′**, then on track 256° to cross TARRK at **11000′**, then on track 256° to cross SHEAD at or above **14000′**.

ROUTING	ALTITUDE
From SHEAD via transition. EXPECT filed altitude 10 minutes after departure.	**MAINTAIN FL190**

OBSTACLES
Rwy 7L: Trees 761′ from DER, LEFT and RIGHT of centerline, up to 42′ AGL/2074′ MSL. Pole 747′ from DER, 442′ RIGHT of centerline, 25′ AGL/2057′ MSL.
Rwy 7R: Tower 1457′ from DER, 847′ RIGHT of centerline, 65′ AGL/2096′ MSL.
Rwy 25L: Multiple poles, sign and buildings 1003′ from DER, 145′ LEFT of centerline, up to 97′ AGL/2291′ MSL. Tree 2837′ from DER, 1008′ LEFT of centerline, 72′ AGL/2230′ MSL. Railroad 2564′ from DER, 773′ LEFT of centerline, 66′ AGL/2223′ MSL.
Rwy 25R: Multiple poles and trees 533′ from DER, 1′ LEFT of centerline, up to 271′ AGL/2457′ MSL. Building 1822′ from DER, 652′ LEFT of centerline, 59′ AGL/2238′ MSL. Roads 669′ from DER, 17′ RIGHT of centerline, up to 29′ AGL/2208′ MSL.

CHANGES: VOLPE/MIT test chart.

Salt Lake City LEETZ TWO

FAA

- Current text
- Current graphic

Modified

- HAYDEN/MEEKER/MYTON text
- HAYDEN/MEEKER/MYTON graphic
- HOLTR text
- HOLTR graphic
- ROCK SPRINGS text
- ROCK SPRINGS graphic

Jeppesen

- Current

Modified

- HAYDEN/MEEKER/MYTON
- HOLTR
- ROCK SPRINGS

(LEETZ2.LEETZ) 08325 SL-365 (FAA)

LEETZ TWO DEPARTURE (RNAV)

SALT LAKE CITY INTL (SLC)
SALT LAKE CITY, UTAH

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAYS 16R/16L: Climb heading 161° to 4727, then right turn direct PPIGG, then via depicted route to LEETZ, thence....
TAKE-OFF RUNWAY 17: Climb heading 166° to 4727, then right turn direct PPIGG, then via depicted route to LEETZ, thence....

....via (transition) maintain FL230 or lower filed altitude. Expect filed altitude 10 minutes after departure.

HAYDEN TRANSITION (LEETZ2.CHE)
HOLTR TRANSITION (LEETZ2.HOLTR)
MEEKER TRANSITION (LEETZ2.EKR)
MYTON TRANSITION (LEETZ2.MTU)
ROCK SPRINGS TRANSITION (LEETZ2.OCS)

TAKE-OFF NOTES CONT.

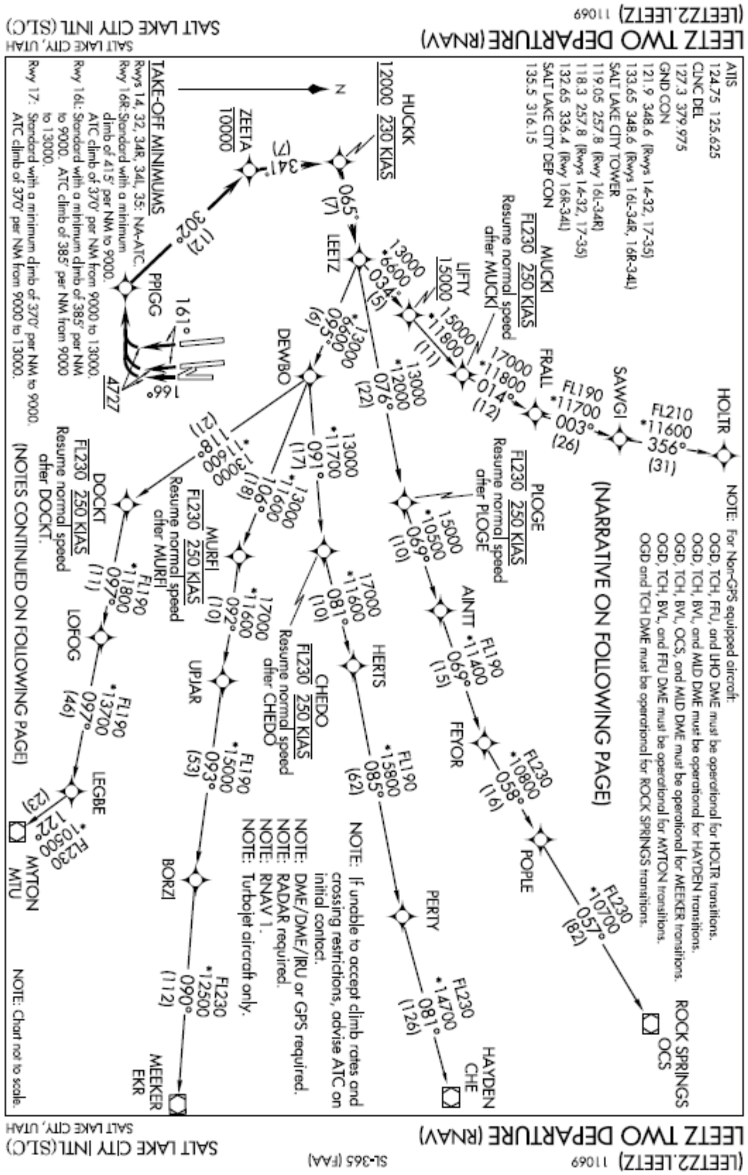
TAKE-OFF OBSTACLES

Rwy 16L, 16R, and 17: Multiple light poles beginning 988' from DER, 689' right of centerline, up to 34' AGL/4254' MSL.
Rwy 17: Vehicle on road 434' from DER, 518' right of centerline, 17' AGL/4237' MSL.

LEETZ TWO DEPARTURE (RNAV)
(LEETZ2.LEETZ) 08325
SALT LAKE CITY, UTAH
SALT LAKE CITY INTL (SLC)

SW-4, 10 FEB 2011 to 10 MAR 2011

SW-4, 10 FEB 2011 to 10 MAR 2011
SW-4, 10 MAR 2011 to 07 APR 2011



SW-4, 10 MAR 2011 to 07 APR 2011

LEETZ TWO DEPARTURE (RNAV)

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAYS 16R/16L: Climb heading 161° to 4727, then right turn direct PPIGG, then via depicted route to LEETZ, thence....

TAKE-OFF RUNWAY 17: Climb heading 166° to 4727, then right turn direct PPIGG, then via depicted route to LEETZ, thence....

....via (transition) maintain FL230 or lower filed altitude. Expect filed altitude 10 minutes after departure.

HAYDEN TRANSITION (LEETZ2.CHE)

MEEKER TRANSITION (LEETZ2.EKR)

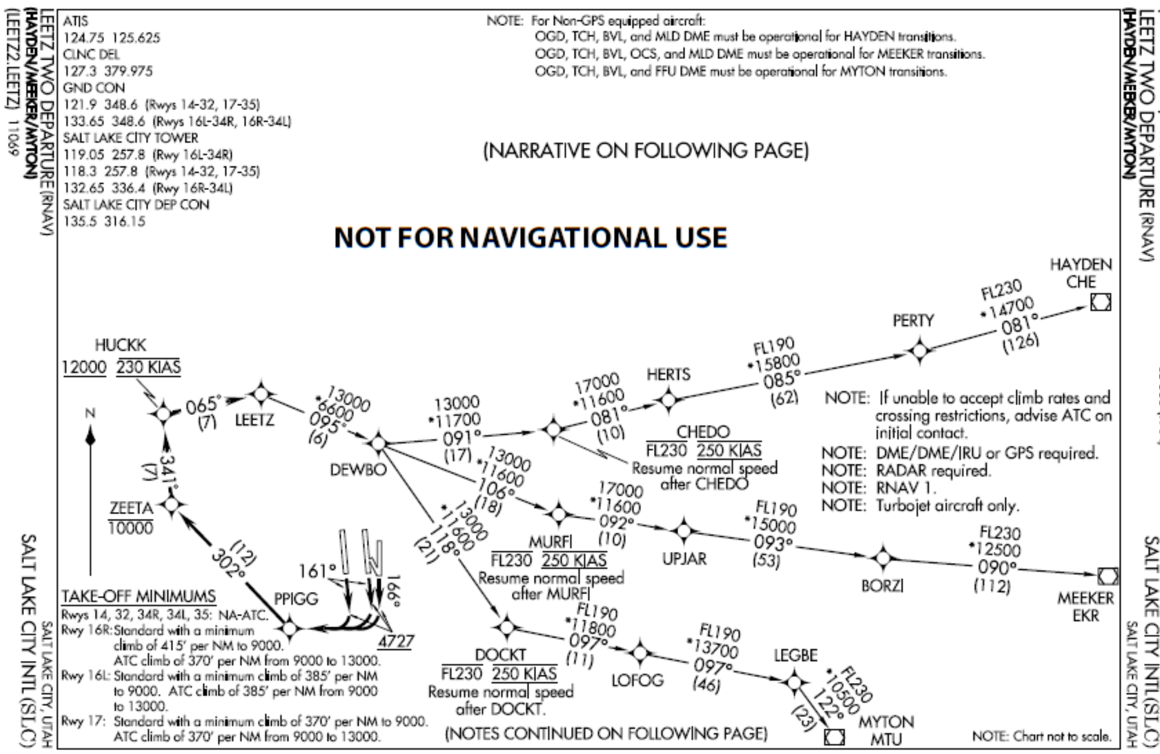
MYTON TRANSITION (LEETZ2.MTU)

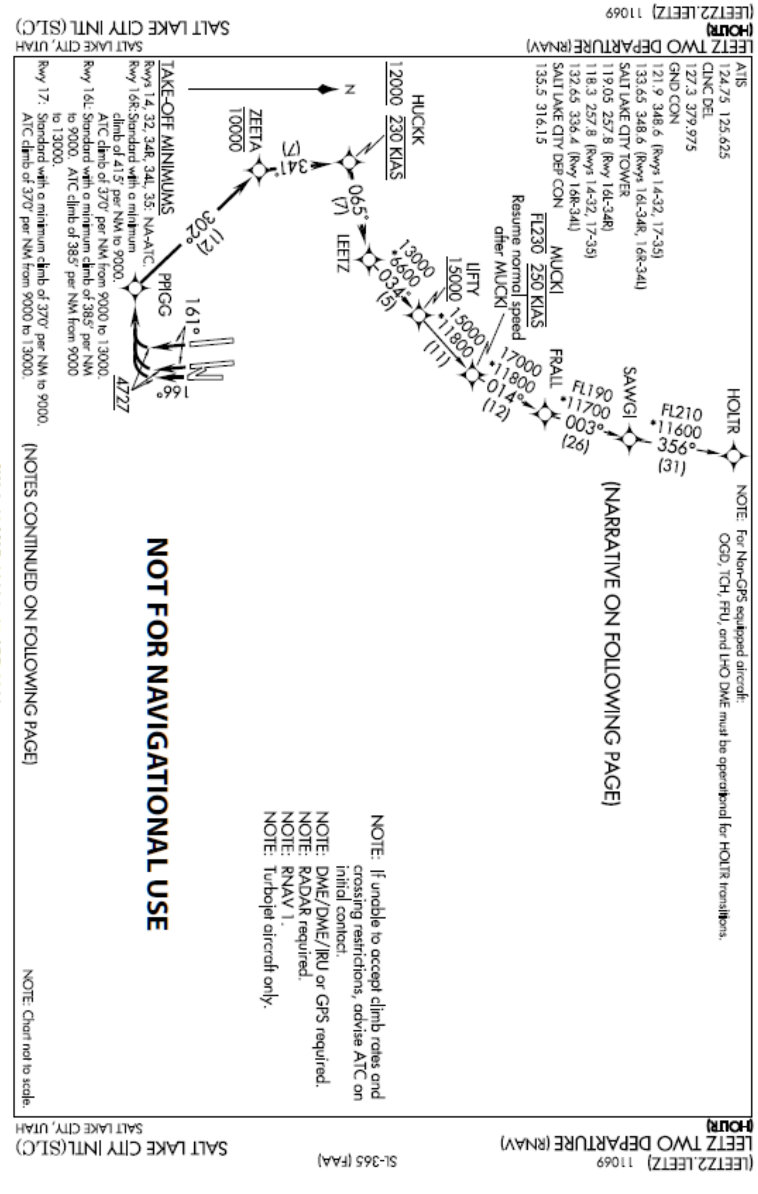
TAKE-OFF NOTES CONT.

TAKE-OFF OBSTACLES

Rwy 16L, 16R, and 17: Multiple light poles beginning 988' from DER, 689' right of centerline, up to 34' AGL/4254' MSL.

Rwy 17: Vehicle on road 434' from DER, 518' right of centerline, 17' AGL/4237' MSL.





SW-4, 10 MAR 2011 to 07 APR 2011

SW-4, 10 FEB 2011 to 10 MAR 2011

(LEETZ2.LEETZ) 08325 SL-365 (FAA) SALT LAKE CITY INTL (SLC) SALT LAKE CITY, UTAH

LEETZ TWO DEPARTURE (RNAV)

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAYS 16R/16L: Climb heading 161° to 4727, then right turn direct PPIGG, then via depicted route to LEETZ, thence....
TAKE-OFF RUNWAY 17: Climb heading 166° to 4727, then right turn direct PPIGG, then via depicted route to LEETZ, thence....

....via (transition) maintain FL230 or lower filed altitude. Expect filed altitude 10 minutes after departure.

HOLTR TRANSITION (LEETZ2.HOLTR)

TAKE-OFF NOTES CONT.

TAKE-OFF OBSTACLES
Rwy 16L, 16R, and 17: Multiple light poles beginning 988' from DER, 689' right of centerline, up to 34' AGL/4254' MSL.
Rwy 17: Vehicle on road 434' from DER, 518' right of centerline, 17' AGL/4237' MSL.

LEETZ TWO DEPARTURE (RNAV)
(LEETZ2.LEETZ) 08325 SALT LAKE CITY, UTAH SALT LAKE CITY INTL (SLC)

SW-4, 10 FEB 2011 to 10 MAR 2011

SW-4, 10 FEB 2011 to 10 MAR 2011

(LEETZ2.LEETZ) 08325 SL-365 (FAA) SALT LAKE CITY INTL (SLC) SALT LAKE CITY, UTAH

LEETZ TWO DEPARTURE (RNAV)

DEPARTURE ROUTE DESCRIPTION

TAKE-OFF RUNWAYS 16R/16L: Climb heading 161° to 4727, then right turn direct PPIGG, then via depicted route to LEETZ, thence....

TAKE-OFF RUNWAY 17: Climb heading 166° to 4727, then right turn direct PPIGG, then via depicted route to LEETZ, thence....

....via (transition) maintain FL230 or lower filed altitude. Expect filed altitude 10 minutes after departure.

ROCK SPRINGS TRANSITION (LEETZ2.OCS)

TAKE-OFF NOTES CONT.

TAKE-OFF OBSTACLES

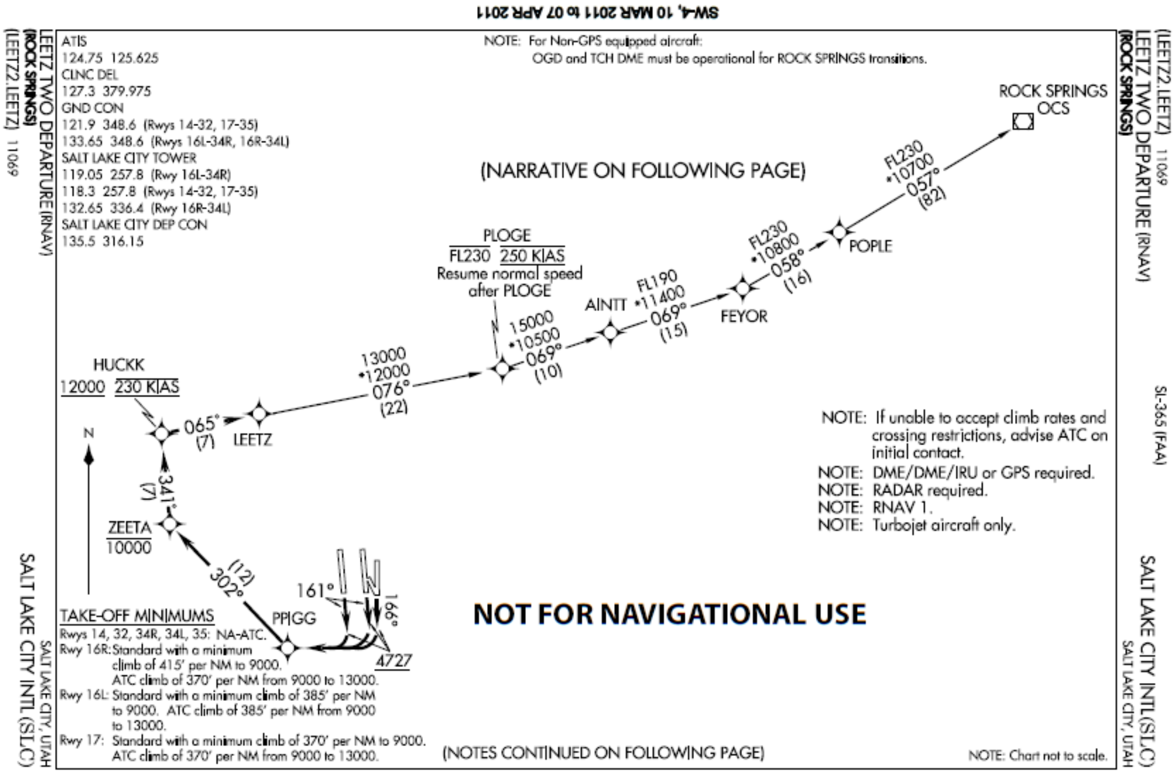
Rwy 16L, 16R, and 17: Multiple light poles beginning 988' from DER, 689' right of centerline, up to 34' AGL/4254' MSL.

Rwy 17: Vehicle on road 434' from DER, 518' right of centerline, 17' AGL/4237' MSL.

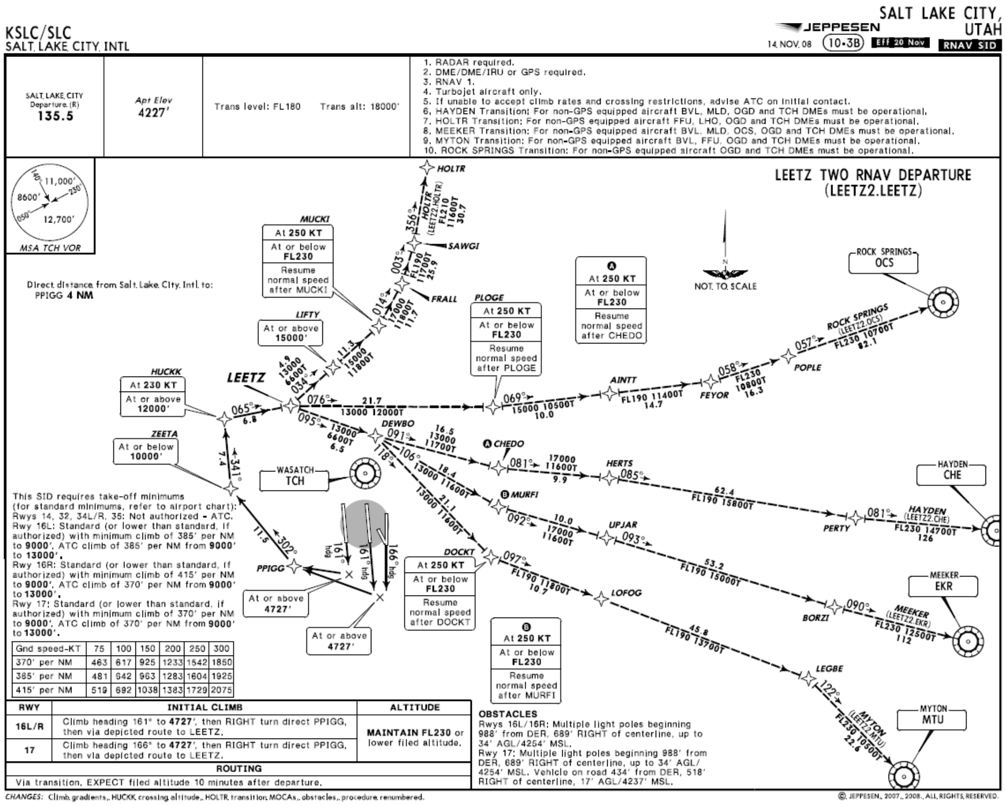
LEETZ TWO DEPARTURE (RNAV) (LEETZ2.LEETZ) 08325 SALT LAKE CITY, UTAH SALT LAKE CITY INTL (SLC)

SW-4, 10 FEB 2011 to 10 MAR 2011

SW-4, 10 MAR 2011 to 07 APR 2011



SW-4, 10 MAR 2011 to 07 APR 2011


KSLC/SLC
SALT LAKE CITY INTL
JEPPESEN
SALT LAKE CITY, UTAH
14 NOV 08 10-3B Eff 20 Nov RNAV SID
SALT LAKE CITY Departure (R) 135.5
Apt Elev 4227'
Trans level: FL180 Trans alt: 18000'
1. RADAR required.
2. DME/DME/IRU or GPS required.
3. RNAV 1.
4. Turbojet aircraft only.
5. If unable to accept climb rates and crossing restrictions, advise ATC on initial contact.
6. HAYDEN Transition: For non-GPS equipped aircraft BVL, MLD, OGD and TCH DMEs must be operational.
7. HOLTR Transition: For non-GPS equipped aircraft FFU, LHO, OGD and TCH DMEs must be operational.
8. MEEKER Transition: For non-GPS equipped aircraft BVL, MLD, OCS, OGD and TCH DMEs must be operational.
9. MYTON Transition: For non-GPS equipped aircraft BVL, FFU, OGD and TCH DMEs must be operational.
10. ROCK SPRINGS Transition: For non-GPS equipped aircraft OGD and TCH DMEs must be operational.
MSA TCH VOR
11,000'
8600'
12,700'
LEETZ TWO RNAV DEPARTURE
(LEETZ2.LEETZ)
NOT TO SCALE
Direct distance from Salt Lake City Intl to: PPIGG 4 NM
HOLTR
SAWGI
FRALL
MUCKI
At 250 KT
At or below FL230
Resume normal speed after MUCKI
LIFTY
At or above 15000'
PLOGE
At 250 KT
At or below FL230
Resume normal speed after PLOGE
A
At 250 KT
At or below FL230
Resume normal speed after CHEDO
ROCK SPRINGS OCS
POPLE
AINTT
FEYOR
HUCKK
At 230 KT
At or above 12000'
LEETZ
ZEETA
At or below 10000'
DEWBO
CHEDO
MURFI
HERTS
UPJAR
DOCKT
At 250 KT
At or below FL230
Resume normal speed after DOCKT
LOFOG
WASATCH TCH
PPIGG
At or above 4727'
At or above 4727'
HAYDEN CHE
PERTY
MEEKER EKR
BORZI
LEGBE
MYTON MTU
B
At 250 KT
At or below FL230
Resume normal speed after MURFI
This SID requires take-off minimums (for standard minimums, refer to airport chart):
Rwys 14, 32, 34L/R, 35: Not authorized - ATC.
Rwy 16L: Standard (or lower than standard, if authorized) with minimum climb of 385' per NM to 9000', ATC climb of 385' per NM from 9000' to 13000'.
Rwy 16R: Standard (or lower than standard, if authorized) with minimum climb of 415' per NM to 9000', ATC climb of 370' per NM from 9000' to 13000'.
Rwy 17: Standard (or lower than standard, if authorized) with minimum climb of 370' per NM to 9000', ATC climb of 370' per NM from 9000' to 13000'.
Gnd speed-KT 75 100 150 200 250 300
370' per NM 463 617 925 1233 1542 1850
385' per NM 481 642 963 1283 1604 1925
415' per NM 519 692 1038 1383 1729 2075
RWY INITIAL CLIMB ALTITUDE
16L/R Climb heading 161° to 4727', then RIGHT turn direct PPIGG, then via depicted route to LEETZ.
17 Climb heading 166° to 4727', then RIGHT turn direct PPIGG, then via depicted route to LEETZ.
MAINTAIN FL230 or lower filed altitude.
ROUTING
Via transition. EXPECT filed altitude 10 minutes after departure.
OBSTACLES
Rwys 16L/16R: Multiple light poles beginning 988' from DER, 689' RIGHT of centerline, up to 34' AGL/4254' MSL.
Rwy 17: Multiple light poles beginning 988' from DER, 689' RIGHT of centerline, up to 34' AGL/4254' MSL. Vehicle on road 434' from DER, 518' RIGHT of centerline, 17' AGL/4237' MSL.
CHANGES: Climb gradients, HUCKK crossing altitude, HOLTR transition MOCAs, obstacles, procedure renumbered.
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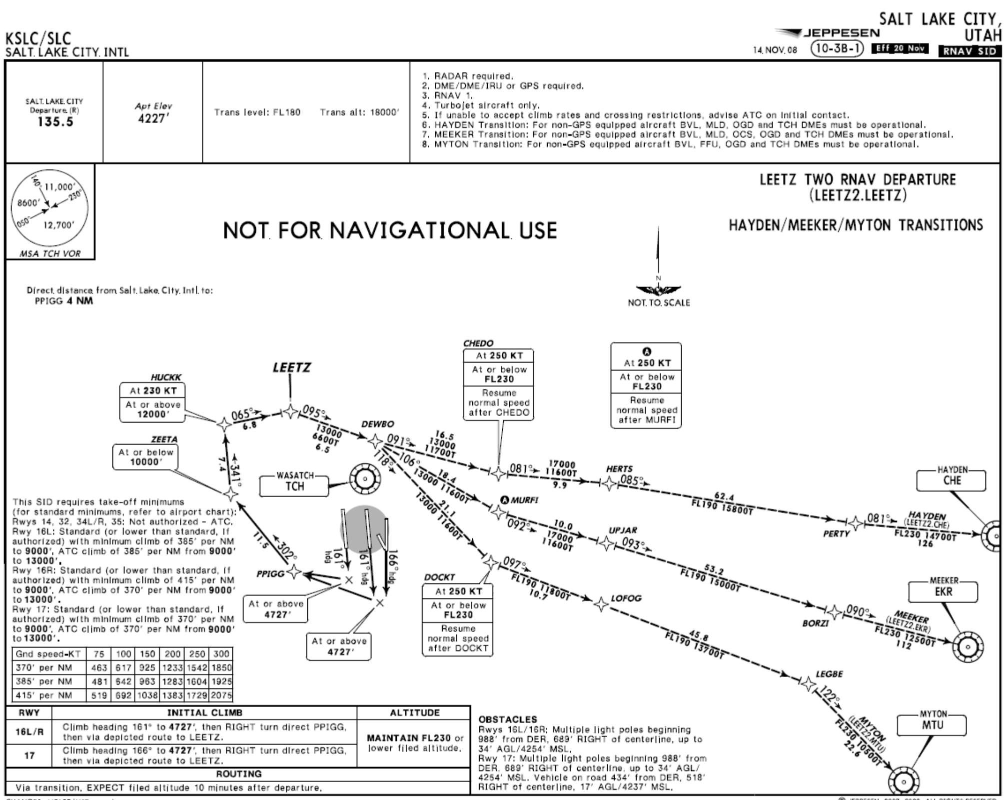
KSLC/SLC
SALT LAKE CITY INTL
JEPPESEN
SALT LAKE CITY, UTAH
14 NOV 08 10-3B-1 Eff 20 Nov RNAV SID
SALT LAKE CITY Departure (R) 135.5
Apt Elev 4227'
Trans level: FL180 Trans alt: 18000'
1. RADAR required.
2. DME/DME/IRU or GPS required.
3. RNAV 1.
4. Turbojet aircraft only.
5. If unable to accept climb rates and crossing restrictions, advise ATC on initial contact.
6. HAYDEN Transition: For non-GPS equipped aircraft BVL, MLD, OGD and TCH DMEs must be operational.
7. MEEKER Transition: For non-GPS equipped aircraft BVL, MLD, OCS, OGD and TCH DMEs must be operational.
8. MYTON Transition: For non-GPS equipped aircraft BVL, FFU, OGD and TCH DMEs must be operational.
MSA TCH VOR
NOT FOR NAVIGATIONAL USE
LEETZ TWO RNAV DEPARTURE
(LEETZ2.LEETZ)
HAYDEN/MEEKER/MYTON TRANSITIONS
NOT TO SCALE
Direct distance from Salt Lake City Intl to: PPIGG 4 NM
CHEDO
At 250 KT
At or below FL230
Resume normal speed after CHEDO
A
At 250 KT
At or below FL230
Resume normal speed after MURFI
HUCKK
At 230 KT
At or above 12000'
LEETZ
ZEETA
At or below 10000'
DOCKT
At 250 KT
At or below FL230
Resume normal speed after DOCKT
This SID requires take-off minimums (for standard minimums, refer to airport chart):
Rwys 14, 32, 34L/R, 35: Not authorized - ATC.
Rwy 16L: Standard (or lower than standard, if authorized) with minimum climb of 385' per NM to 9000', ATC climb of 385' per NM from 9000' to 13000'.
Rwy 16R: Standard (or lower than standard, if authorized) with minimum climb of 415' per NM to 9000', ATC climb of 370' per NM from 9000' to 13000'.
Rwy 17: Standard (or lower than standard, if authorized) with minimum climb of 370' per NM to 9000', ATC climb of 370' per NM from 9000' to 13000'.
Gnd speed-KT 75 100 150 200 250 300
370' per NM 463 617 925 1233 1542 1850
385' per NM 481 642 963 1283 1604 1925
415' per NM 519 692 1038 1383 1729 2075
RWY INITIAL CLIMB ALTITUDE
16L/R Climb heading 161° to 4727', then RIGHT turn direct PPIGG, then via depicted route to LEETZ.
17 Climb heading 166° to 4727', then RIGHT turn direct PPIGG, then via depicted route to LEETZ.
MAINTAIN FL230 or lower filed altitude.
ROUTING
Via transition. EXPECT filed altitude 10 minutes after departure.
OBSTACLES
Rwys 16L/16R: Multiple light poles beginning 988' from DER, 689' RIGHT of centerline, up to 34' AGL/4254' MSL.
Rwy 17: Multiple light poles beginning 988' from DER, 689' RIGHT of centerline, up to 34' AGL/4254' MSL. Vehicle on road 434' from DER, 518' RIGHT of centerline, 17' AGL/4237' MSL.
CHANGES: VOLPE/MIT test chart.
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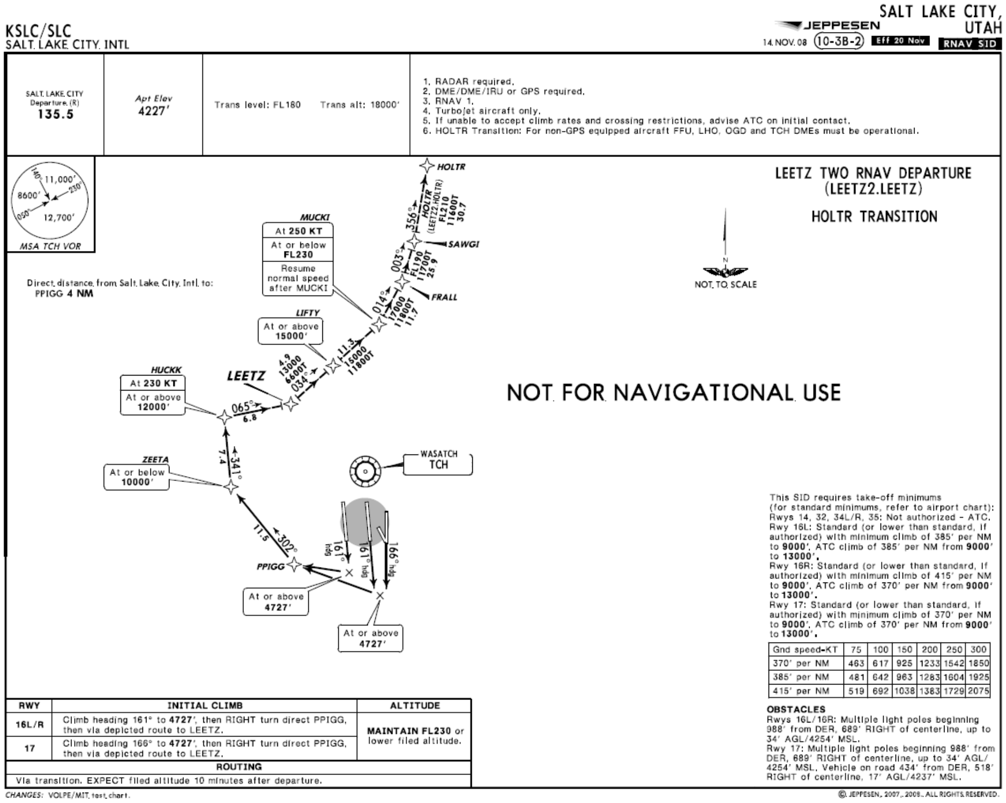


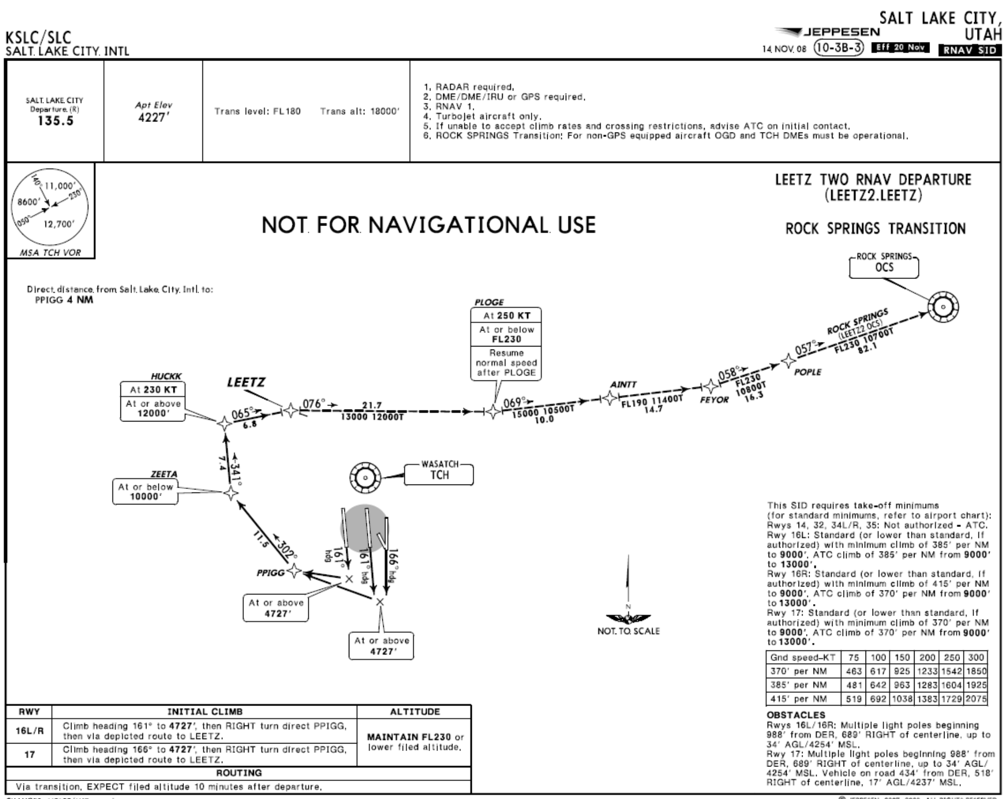
Gnd speed-KT	75	100	150	200	250	300
370' per NM	463	617	925	1233	1542	1850
385' per NM	481	642	963	1283	1604	1925
415' per NM	519	692	1038	1383	1729	2075

OBSTACLES
Rwys 16L/16R: Multiple light poles beginning 988' from DER, 689' RIGHT of centerline, up to 34' AGL/4254' MSL.
Rwy 17: Multiple light poles beginning 988' from DER, 689' RIGHT of centerline, up to 34' AGL/4254' MSL. Vehicle on road 434' from DER, 518' RIGHT of centerline, 17' AGL/4237' MSL.

RWY	INITIAL CLIMB	ALTITUDE
16L/R	Climb heading 161° to **4727'**, then RIGHT turn direct PPIGG, then via depicted route to LEETZ.	**MAINTAIN FL230** or lower filed altitude.
17	Climb heading 166° to **4727'**, then RIGHT turn direct PPIGG, then via depicted route to LEETZ.	

ROUTING
Via transition. EXPECT filed altitude 10 minutes after departure.

CHANGES: VOLPE/MIT test chart.



Gnd speed-KT	75	100	150	200	250	300
370' per NM	463	617	925	1233	1542	1850
385' per NM	481	642	963	1283	1604	1925
415' per NM	519	692	1038	1383	1729	2075

OBSTACLES
Rwys 16L/16R: Multiple light poles beginning 988' from DER, 689' RIGHT of centerline, up to 34' AGL/4254' MSL.
Rwy 17: Multiple light poles beginning 988' from DER, 689' RIGHT of centerline, up to 34' AGL/4254' MSL. Vehicle on road 434' from DER, 518' RIGHT of centerline, 17' AGL/4237' MSL.

RWY	INITIAL CLIMB	ALTITUDE
16L/R	Climb heading 161° to **4727'**, then RIGHT turn direct PPIGG, then via depicted route to LEETZ.	**MAINTAIN FL230** or lower filed altitude.
17	Climb heading 166° to **4727'**, then RIGHT turn direct PPIGG, then via depicted route to LEETZ.	

ROUTING
Via transition. EXPECT filed altitude 10 minutes after departure.

CHANGES: VOLPE/MIT test chart.

Boise RNAV (RNP) Z RWY 28L

FAA

- Current

Modified

- BANGS/EMETT
- CADKI/PARMO
- CANEK/EREXE/UTEGE
- RENOL

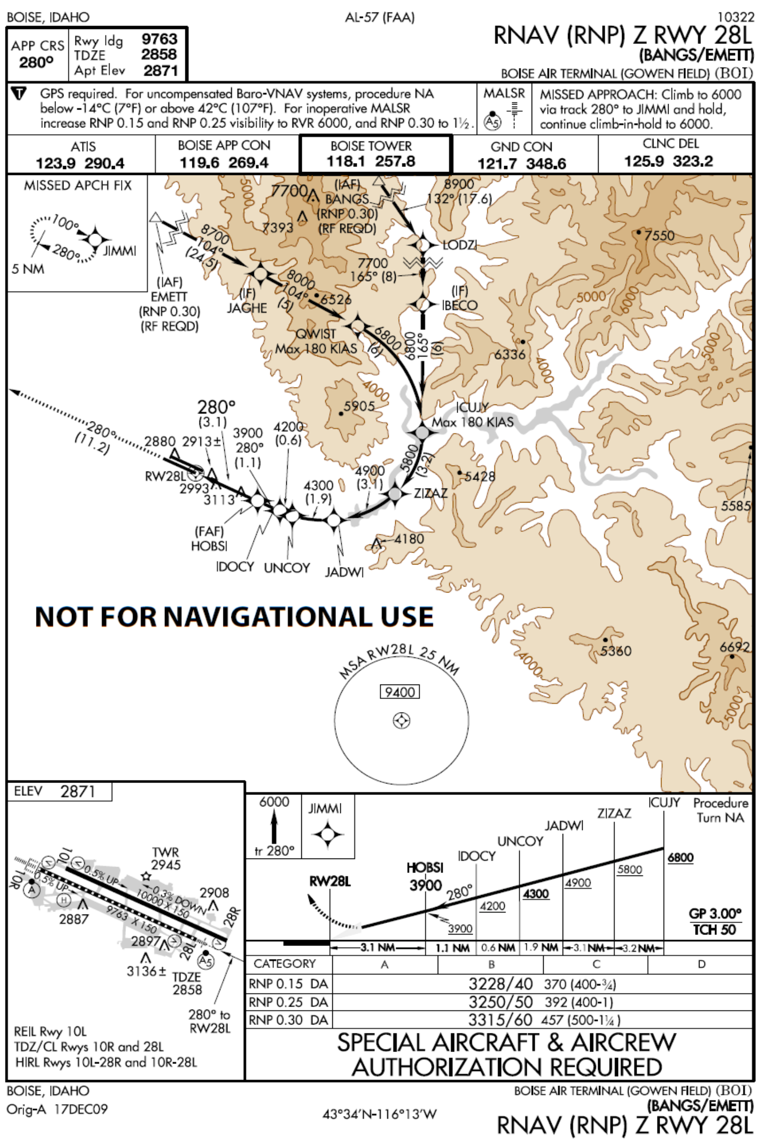
Jeppesen

- Current Initial
- Current Final

Modified

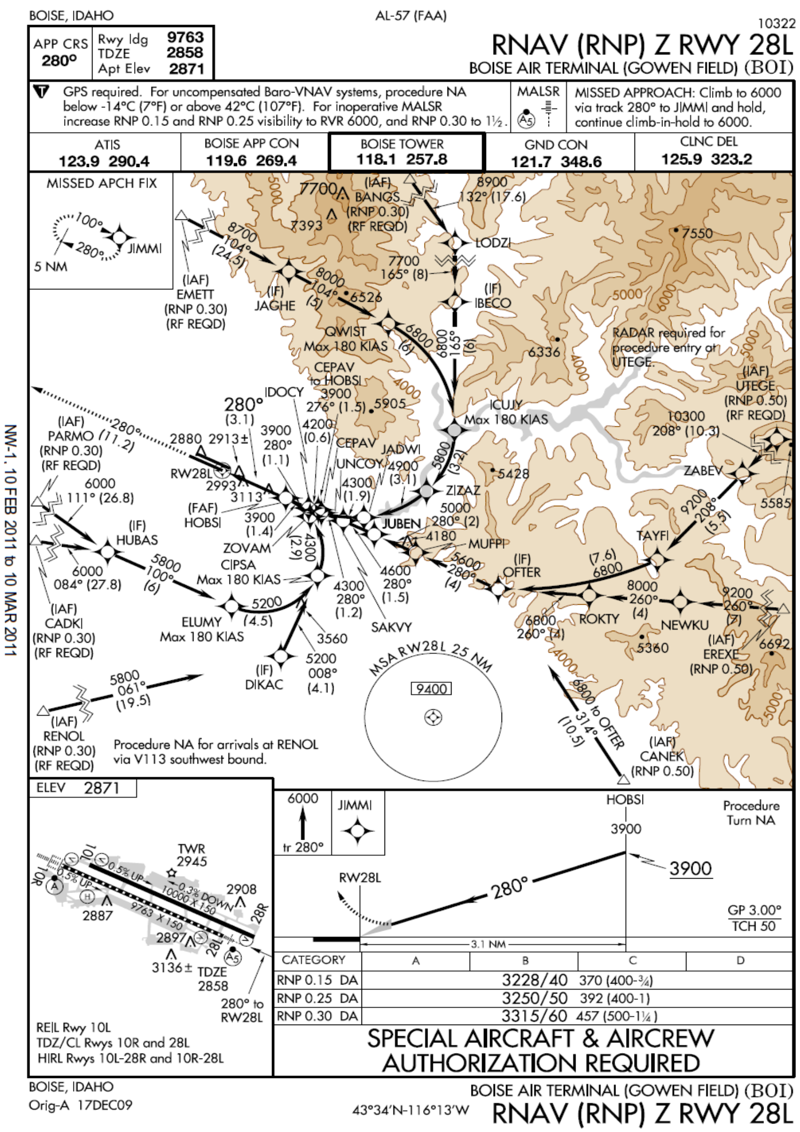
- BANGS/EMETT
- CADKI/PARMO
- CANEK/EREXE/UTEGE
- RENOL
- Final

NW-1, 10 MAR 2011 to 07 APR 2011

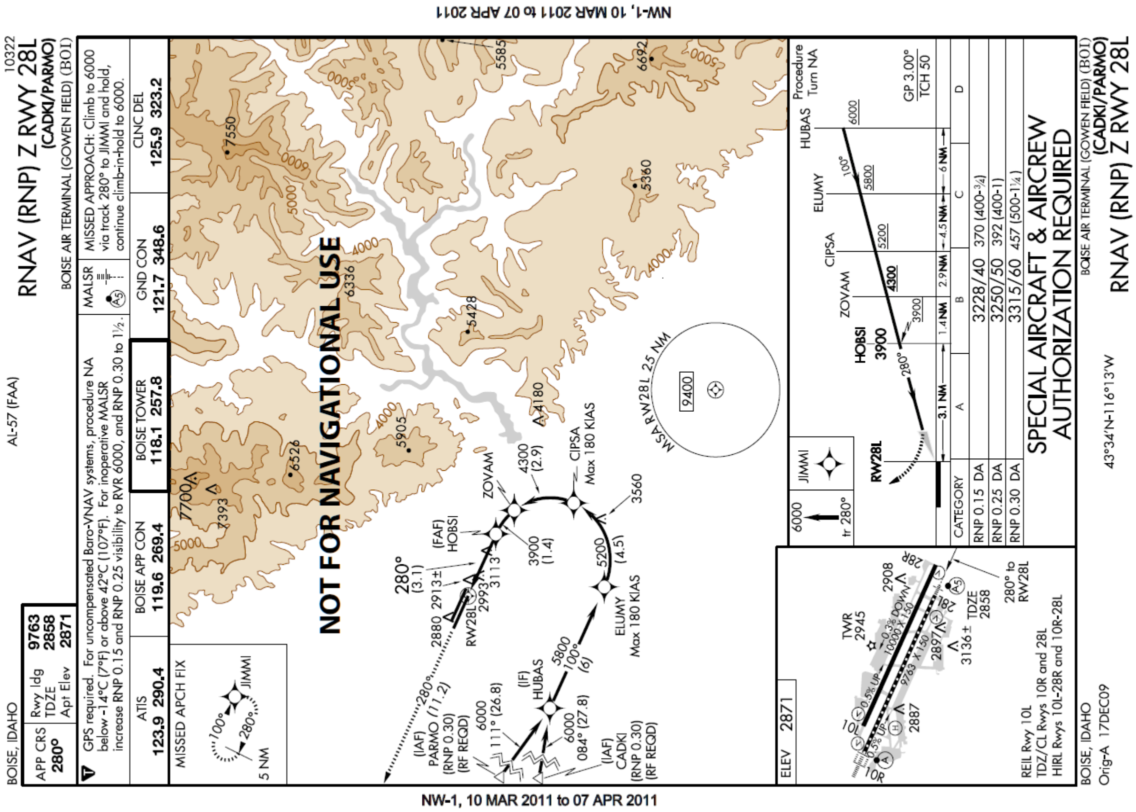


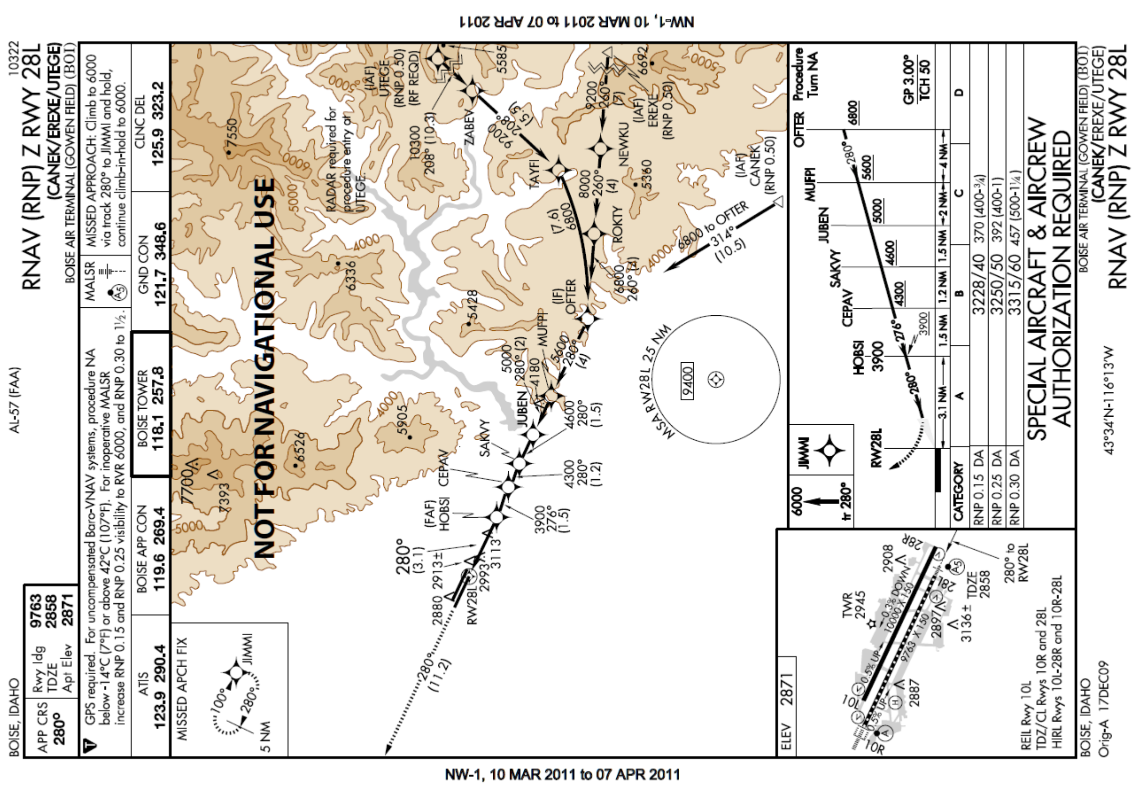
NW-1, 10 MAR 2011 to 07 APR 2011

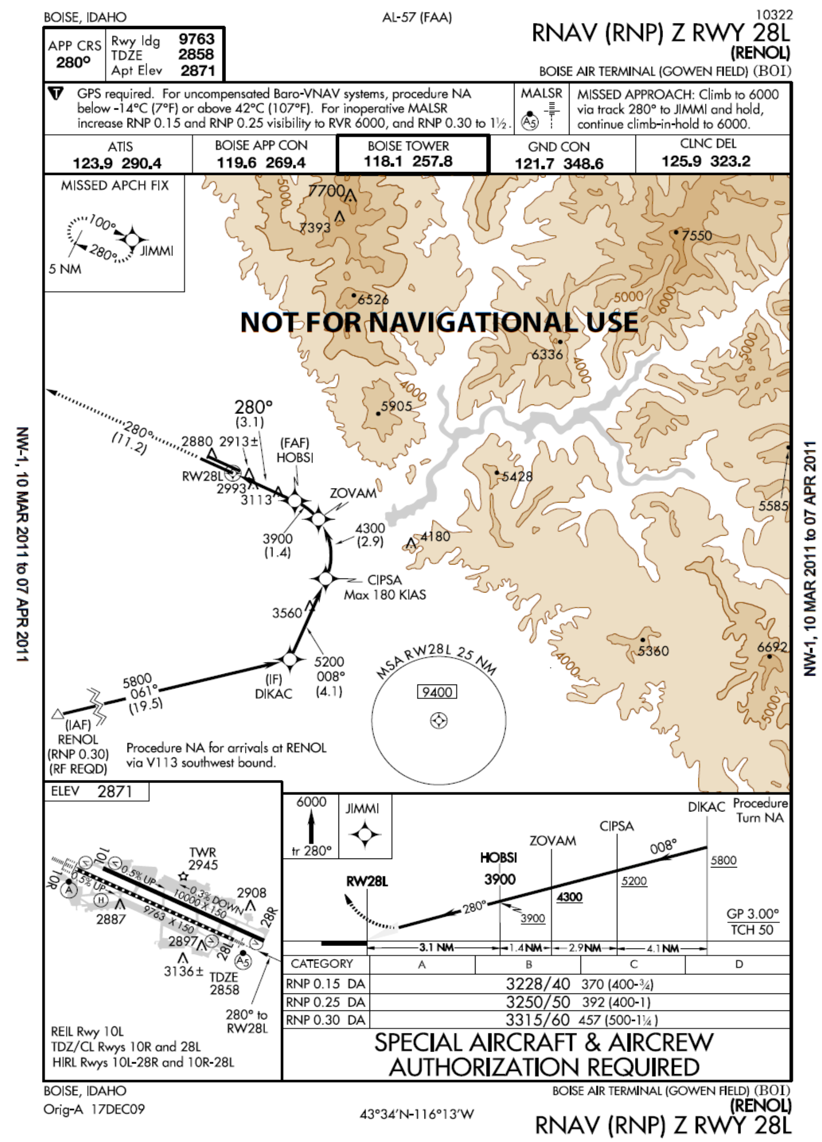
NW-1, 10 FEB 2011 to 10 MAR 2011



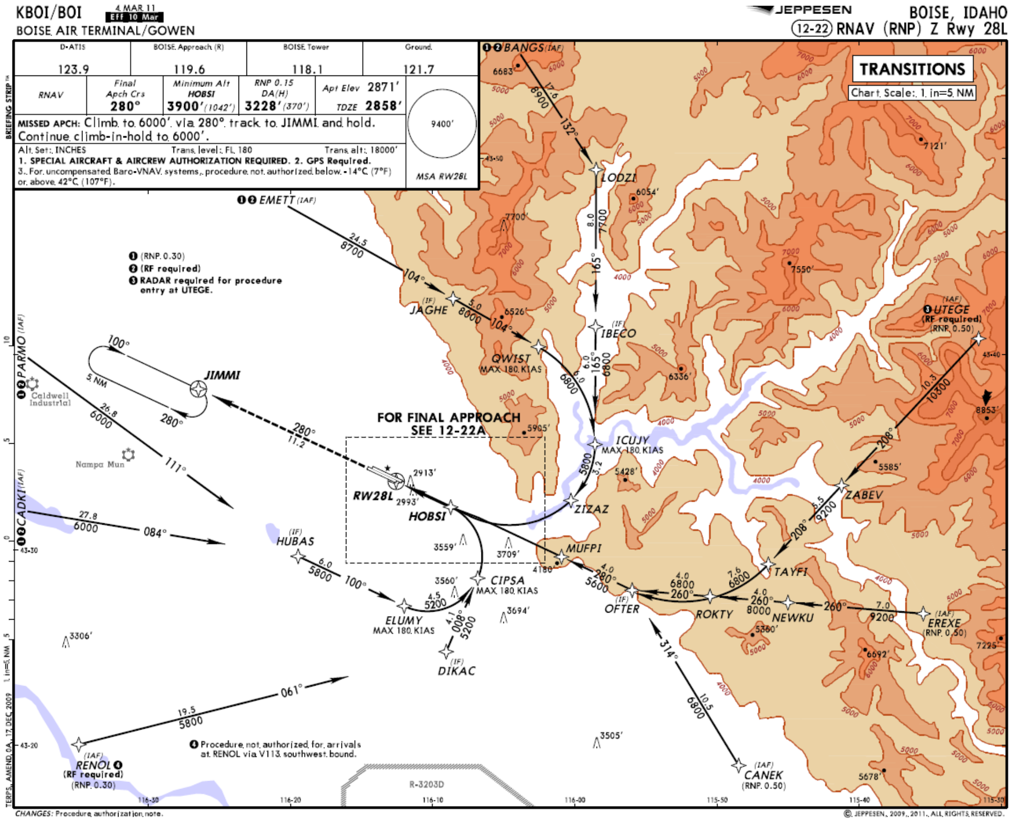
NW-1, 10 FEB 2011 to 10 MAR 2011


BOISE, IDAHO
AL-57 (FAA)
10322
RNAV (RNP) Z RWY 28L
(CADKI/PARMO)
BOISE AIR TERMINAL (GOWEN FIELD) (BOI)
APP CRS 280°
Rwy ldg 9763
TDZE 2858
Apt Elev 2871
GPS required. For uncompensated Baro-VNAV systems, procedure NA below -14°C (7°F) or above 42°C (107°F). For inoperative MALSR increase RNP 0.15 and RNP 0.25 visibility to RVR 6000, and RNP 0.30 to 1½.
MALSR
MISSED APPROACH: Climb to 6000 via track 280° to JIMMI and hold, continue climb-in-hold to 6000.
ATIS 123.9 290.4
BOISE APP CON 119.6 269.4
BOISE TOWER 118.1 257.8
GND CON 121.7 348.6
CLNC DEL 125.9 323.2
MISSED APCH FIX
JIMMI
5 NM
NOT FOR NAVIGATIONAL USE
(IAF) PARMO (RNP 0.30) (RF REQD)
(IAF) CADKI (RNP 0.30) (RF REQD)
(IF) HUBAS
(FAF) HOBSI
ZOVAM
CIPSA Max 180 KIAS
ELUMY Max 180 KIAS
MSA RW28L 25 NM
9400
ELEV 2871
TWR 2945
REIL Rwy 10L
TDZ/CL Rwys 10R and 28L
HIRL Rwys 10L-28R and 10R-28L
CATEGORY A B C D
RNP 0.15 DA 3228/40 370 (400-¾)
RNP 0.25 DA 3250/50 392 (400-1)
RNP 0.30 DA 3315/60 457 (500-1¼)
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED
GP 3.00° TCH 50
Procedure Turn NA
BOISE, IDAHO
Orig-A 17DEC09
43°34'N-116°13'W
NW-1, 10 MAR 2011 to 07 APR 2011


BOISE, IDAHO
AL-57 (FAA)
10322
RNAV (RNP) Z RWY 28L
(CANEK/EREXE/UTEGE)
BOISE AIR TERMINAL (GOWEN FIELD) (BOI)
APP CRS 280°
Rwy ldg 9763
TDZE 2858
Apt Elev 2871
GPS required. For uncompensated Baro-VNAV systems, procedure NA below -14°C (7°F) or above 42°C (107°F). For inoperative MALSR increase RNP 0.15 and RNP 0.25 visibility to RVR 6000, and RNP 0.30 to 1½.
MALSR
MISSED APPROACH: Climb to 6000 via track 280° to JIMMI and hold, continue climb-in-hold to 6000.
ATIS 123.9 290.4
BOISE APP CON 119.6 269.4
BOISE TOWER 118.1 257.8
GND CON 121.7 348.6
CLNC DEL 125.9 323.2
MISSED APCH FIX
JIMMI
5 NM
NOT FOR NAVIGATIONAL USE
RADAR required for procedure entry at UTEGE.
(IAF) UTEGE (RNP 0.50) (RF REQD)
(IAF) EREXE (RNP 0.50)
(IAF) CANEK (RNP 0.50)
(IF) OFTER
(FAF) HOBSI
CEPAV
SAKVY
JUBEN
MUFFI
ROKTY
NEWKU
TAYFI
ZABEV
MSA RW28L 25 NM
9400
ELEV 2871
TWR 2945
REIL Rwy 10L
TDZ/CL Rwys 10R and 28L
HIRL Rwys 10L-28R and 10R-28L
CATEGORY A B C D
RNP 0.15 DA 3228/40 370 (400-¾)
RNP 0.25 DA 3250/50 392 (400-1)
RNP 0.30 DA 3315/60 457 (500-1¼)
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED
GP 3.00° TCH 50
Procedure Turn NA
BOISE, IDAHO
Orig-A 17DEC09
43°34'N-116°13'W
NW-1, 10 MAR 2011 to 07 APR 2011



NW-1, 10 MAR 2011 to 07 APR 2011
BOISE, IDAHO
AL-57 (FAA)
10322
RNAV (RNP) Z RWY 28L
(RENOL)
BOISE AIR TERMINAL (GOWEN FIELD) (BOI)
APP CRS 280°
Rwy ldg 9763
TDZE 2858
Apt Elev 2871
GPS required. For uncompensated Baro-VNAV systems, procedure NA below -14°C (7°F) or above 42°C (107°F). For inoperative MALSR increase RNP 0.15 and RNP 0.25 visibility to RVR 6000, and RNP 0.30 to 1½.
MALSR
MISSED APPROACH: Climb to 6000 via track 280° to JIMMI and hold, continue climb-in-hold to 6000.
ATIS 123.9 290.4
BOISE APP CON 119.6 269.4
BOISE TOWER 118.1 257.8
GND CON 121.7 348.6
CLNC DEL 125.9 323.2
MISSED APCH FIX
100°
280°
JIMMI
5 NM
NOT FOR NAVIGATIONAL USE
280° (3.1)
280° (11.2)
2880 2913±
(FAF) HOBSI
RW28L
2993
3113
ZOVAM
3900 (1.4)
4300 (2.9)
4180
CIPSA
Max 180 KIAS
3560
5200 008° (4.1)
(IF) DIKAC
5800 061° (19.5)
(IAF) RENOL (RNP 0.30) (RF REQD)
Procedure NA for arrivals at RENOL via V113 southwest bound.
MSA RW28L 25 NM
9400
7700
7393
6526
7550
6336
5905
5428
5585
5360
6692
ELEV 2871
TWR 2945
2908
2887
10000 X 150
9763 X 150
0.5% UP
0.3% DOWN
2897
3136±
TDZE 2858
280° to RW28L
REIL Rwy 10L
TDZ/CL Rwys 10R and 28L
HIRL Rwys 10L-28R and 10R-28L
6000
fr 280°
JIMMI
RW28L
HOBSI 3900
ZOVAM
4300
CIPSA
5200
008°
DIKAC
5800
Procedure Turn NA
GP 3.00° TCH 50
3.1 NM
1.4 NM
2.9 NM
4.1 NM
CATEGORY A B C D
RNP 0.15 DA 3228/40 370 (400-¾)
RNP 0.25 DA 3250/50 392 (400-1)
RNP 0.30 DA 3315/60 457 (500-1¼)
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED
BOISE, IDAHO
Orig-A 17DEC09
43°34'N-116°13'W
BOISE AIR TERMINAL (GOWEN FIELD) (BOI)
(RENOL)
RNAV (RNP) Z RWY 28L
NW-1, 10 MAR 2011 to 07 APR 2011


KBOI/BOI
4 MAR 11 Eff 10 Mar
BOISE AIR TERMINAL/GOWEN
JEPPESEN
BOISE, IDAHO
12-22 RNAV (RNP) Z Rwy 28L
D-ATIS 123.9
BOISE Approach (R) 119.6
BOISE Tower 118.1
Ground 121.7
RNAV
Final Apch Crs 280°
Minimum Alt HOBSI 3900′(1042′)
RNP 0.15 DA(H) 3228′(370′)
Apt Elev 2871′
TDZE 2858′
MISSED APCH: Climb to 6000′ via 280° track to JIMMI and hold. Continue climb-in-hold to 6000′.
Alt Set: INCHES
Trans level: FL 180
Trans alt: 18000′
1. SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED. 2. GPS Required.
3. For uncompensated Baro-VNAV systems, procedure not authorized below -14°C (7°F) or above 42°C (107°F).
9400′
MSA RW28L
TRANSITIONS
Chart Scale: 1 in=5 NM
BANGS (IAF)
LODZI
EMETT (IAF)
JAGHE
QWIST MAX 180 KIAS
IBECO
ICUJY MAX 180 KIAS
ZIZAZ
MUFPI
UTEGE (IAF) (RF required) (RNP 0.50)
ZABEV
TAYFI
NEWKU
ROKTY
OFTER
EREXE (IAF) (RNP 0.50)
CANEK (IAF) (RNP 0.50)
CIPSA MAX 180 KIAS
ELUMY MAX 180 KIAS
DIKAC
HUBAS
HOBSI
RW28L
JIMMI
PARMO (IAF)
CADKI (IAF)
RENOL (IAF) (RF required) (RNP 0.30)
Caldwell Industrial
Nampa Mun
FOR FINAL APPROACH SEE 12-22A
(RNP 0.30)
(RF required)
RADAR required for procedure entry at UTEGE.
Procedure not authorized for arrivals at RENOL via V113 southwest bound.
R-3203D
CHANGES: Procedure authorization note.
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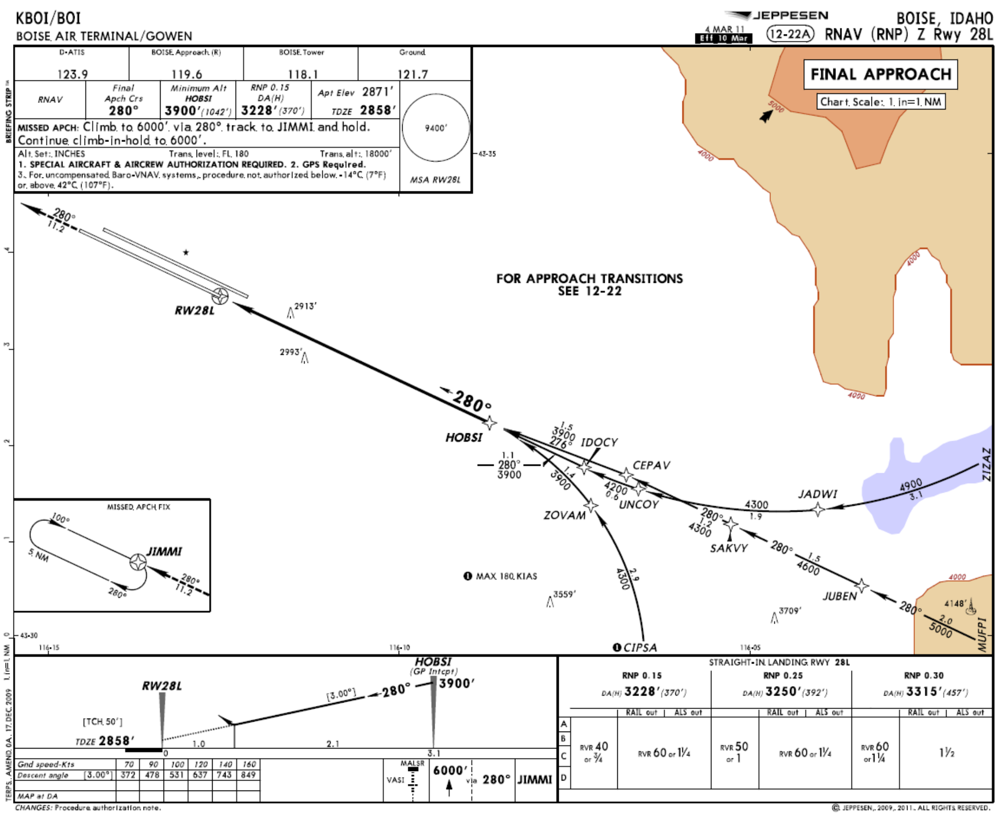
KBOI/BOI
BOISE AIR TERMINAL/GOWEN
JEPPESEN
BOISE, IDAHO
4 MAR 11 Eff 10 Mar
12-22A RNAV (RNP) Z Rwy 28L
D-ATIS 123.9
BOISE Approach (R) 119.6
BOISE Tower 118.1
Ground 121.7
RNAV
Final Apch Crs 280°
Minimum Alt HOBSI 3900′(1042′)
RNP 0.15 DA(H) 3228′(370′)
Apt Elev 2871′
TDZE 2858′
MISSED APCH: Climb to 6000′ via 280° track to JIMMI and hold. Continue climb-in-hold to 6000′.
Alt Set: INCHES
Trans level: FL 180
Trans alt: 18000′
1. SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED. 2. GPS Required.
3. For uncompensated Baro-VNAV systems, procedure not authorized below -14°C (7°F) or above 42°C (107°F).
9400′
MSA RW28L
FINAL APPROACH
Chart Scale: 1 in=1 NM
FOR APPROACH TRANSITIONS SEE 12-22
RW28L
HOBSI
IDOCY
CEPAV
UNCOY
ZOVAM
JADWI
SAKVY
JUBEN
ZIZAZ
MUFPI
CIPSA
MISSED APCH FIX
JIMMI
MAX 180 KIAS
HOBSI (GP Intcpt)
3900′
TCH 50′
TDZE 2858′
Gnd speed-Kts 70 90 100 120 140 160
Descent angle 3.00° 372 478 531 637 743 849
MAP at DA
6000′ via 280° JIMMI
STRAIGHT-IN LANDING RWY 28L
RNP 0.15 DA(H) 3228′(370′)
RNP 0.25 DA(H) 3250′(392′)
RNP 0.30 DA(H) 3315′(457′)
RAIL out ALS out
RVR 40 or ¾
RVR 60 or 1¼
RVR 50 or 1
RVR 60 or 1¼
RVR 60 or 1¼
1½
CHANGES: Procedure authorization note.
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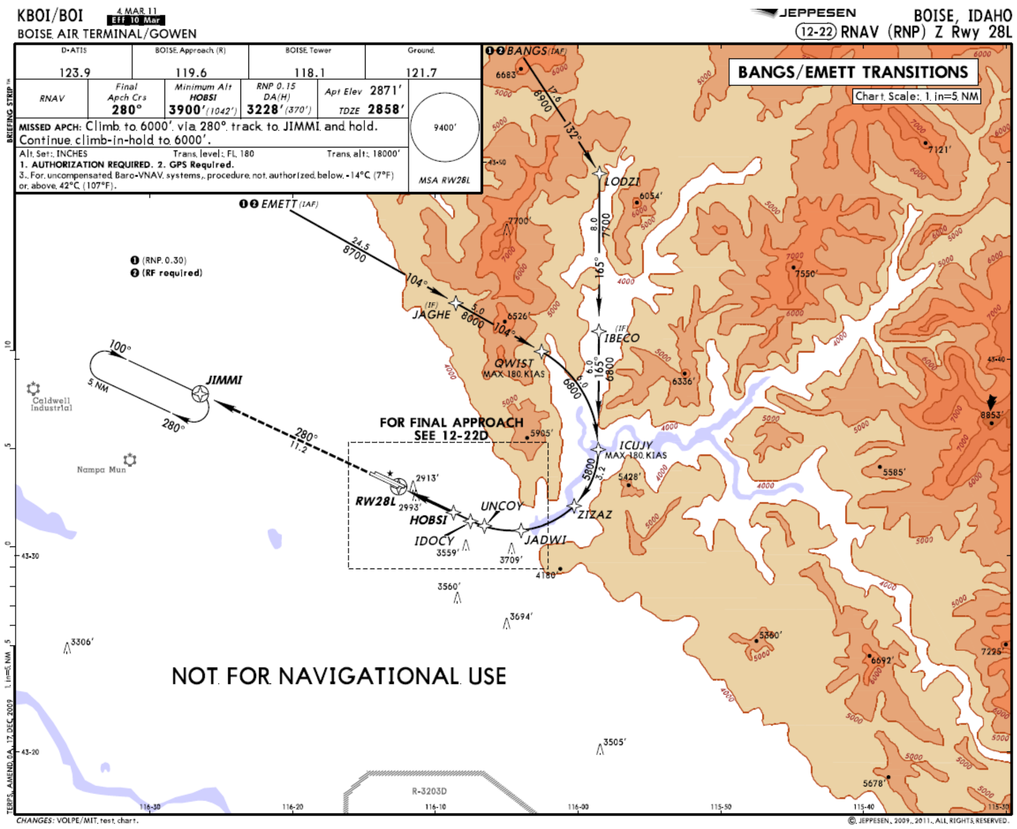
KBOI/BOI
4 MAR 11 Eff 10 Mar
BOISE AIR TERMINAL/GOWEN
JEPPESEN
BOISE, IDAHO
12-22 RNAV (RNP) Z Rwy 28L
D-ATIS 123.9
BOISE Approach (R) 119.6
BOISE Tower 118.1
Ground 121.7
RNAV
Final Apch Crs 280°
Minimum Alt HOBSI 3900′(1042′)
RNP 0.15 DA(H) 3228′(370′)
Apt Elev 2871′
TDZE 2858′
MISSED APCH: Climb to 6000′ via 280° track to JIMMI and hold. Continue climb-in-hold to 6000′.
Alt Set: INCHES
Trans level: FL 180
Trans alt: 18000′
1. AUTHORIZATION REQUIRED. 2. GPS Required.
3. For uncompensated Baro-VNAV systems, procedure not authorized below -14°C (7°F) or above 42°C (107°F).
9400′
MSA RW28L
BANGS/EMETT TRANSITIONS
Chart Scale: 1 in=5 NM
BANGS (IAF)
EMETT (IAF)
(RNP 0.30)
(RF required)
LODZI
JAGHE
QWIST
MAX 180 KIAS
IBECO
ICUJY
MAX 180 KIAS
ZIZAZ
JADWI
UNCOY
HOBSI
IDOCY
RW28L
JIMMI
5 NM
100°
280°
FOR FINAL APPROACH SEE 12-22D
Caldwell Industrial
Nampa Mun
R-3203D
NOT FOR NAVIGATIONAL USE
CHANGES: VOLPE/MIT test chart.
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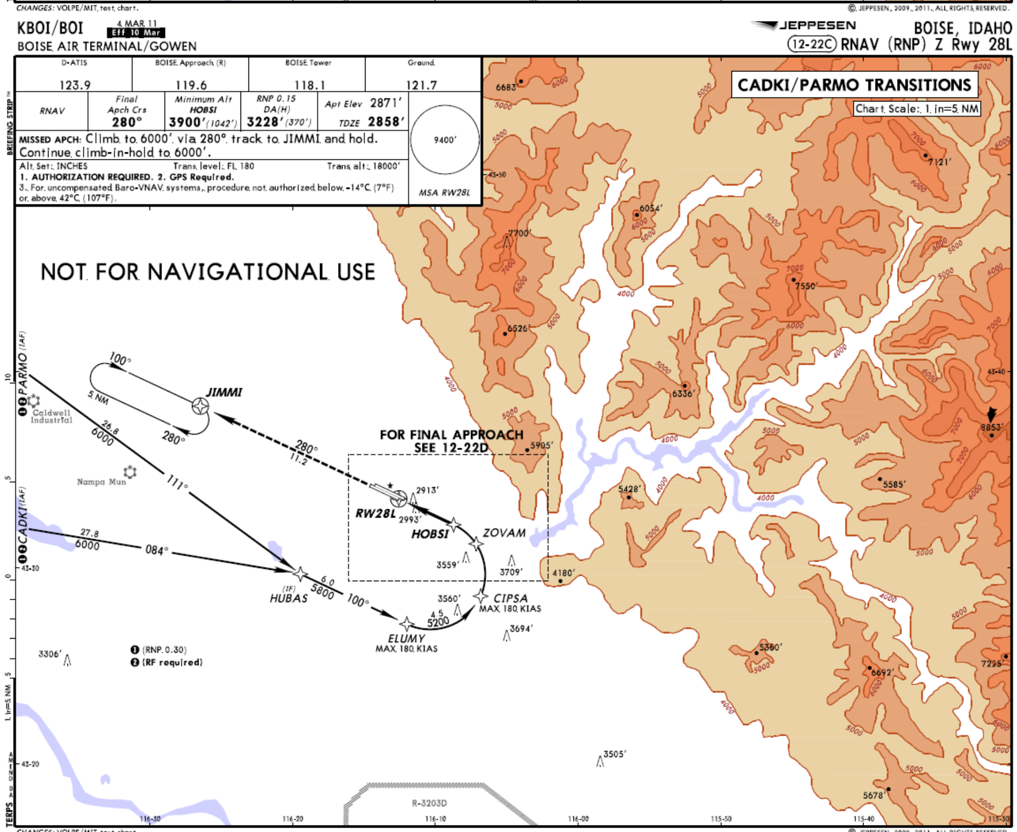
KBOI/BOI
4 MAR 11 Eff 10 Mar
BOISE AIR TERMINAL/GOWEN
JEPPESEN
BOISE, IDAHO
12-22C RNAV (RNP) Z Rwy 28L
D-ATIS 123.9
BOISE Approach (R) 119.6
BOISE Tower 118.1
Ground 121.7
RNAV
Final Apch Crs 280°
Minimum Alt HOBSI 3900′(1042′)
RNP 0.15 DA(H) 3228′(370′)
Apt Elev 2871′
TDZE 2858′
MISSED APCH: Climb to 6000′ via 280° track to JIMMI and hold. Continue climb-in-hold to 6000′.
Alt Set: INCHES
Trans level: FL 180
Trans alt: 18000′
1. AUTHORIZATION REQUIRED. 2. GPS Required.
3. For uncompensated Baro-VNAV systems, procedure not authorized below -14°C (7°F) or above 42°C (107°F).
9400′
MSA RW28L
CADKI/PARMO TRANSITIONS
Chart Scale: 1 in=5 NM
NOT FOR NAVIGATIONAL USE
PARMO (IAF)
CADKI (IAF)
JIMMI
FOR FINAL APPROACH SEE 12-22D
HOBSI
ZOVAM
HUBAS
CIPSA
MAX 180 KIAS
ELUMY
MAX 180 KIAS
(RNP 0.30)
(RF required)
RW28L
Caldwell Industrial
Nampa Mun
R-3203D
CHANGES: VOLPE/MIT test chart.
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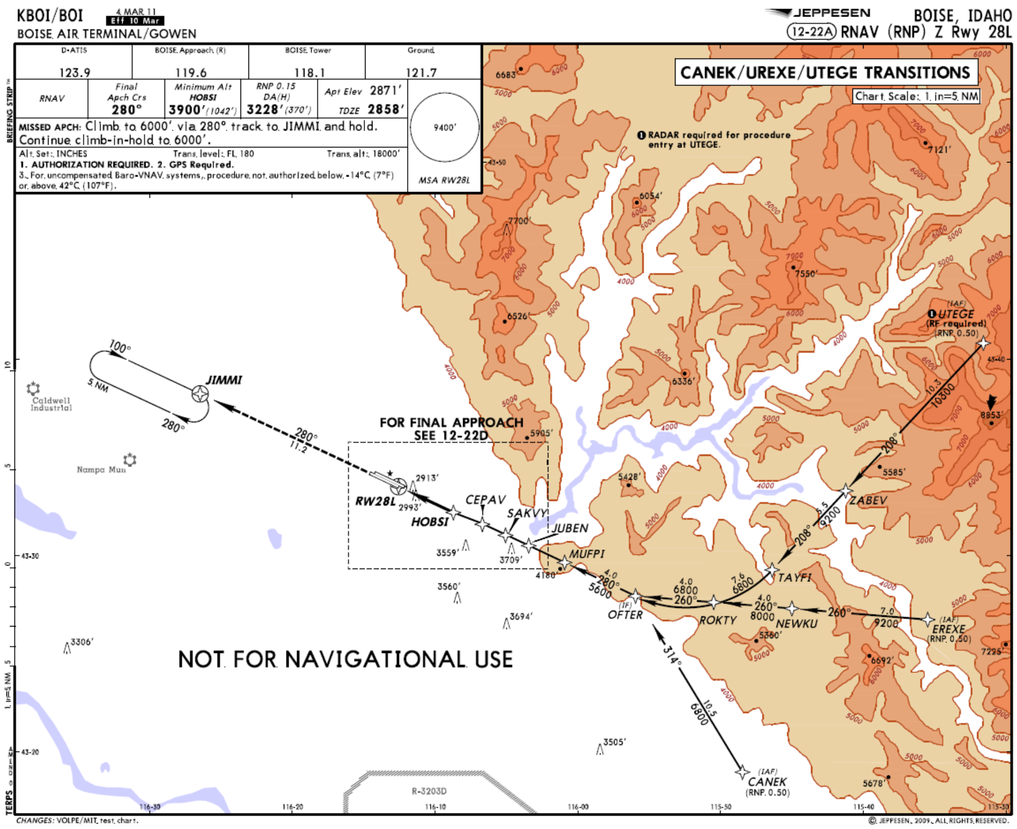
KBOI/BOI
4 MAR 11
Eff 10 Mar
BOISE AIR TERMINAL/GOWEN
JEPPESEN
BOISE, IDAHO
12-22A RNAV (RNP) Z Rwy 28L
D-ATIS 123.9
BOISE Approach (R) 119.6
BOISE Tower 118.1
Ground 121.7
RNAV
Final Apch Crs 280°
Minimum Alt HOBSI 3900′ (1042′)
RNP 0.15 DA(H) 3228′ (370′)
Apt Elev 2871′
TDZE 2858′
9400′
MSA RW28L
MISSED APCH: Climb to 6000′ via 280° track to JIMMI and hold. Continue climb-in-hold to 6000′.
Alt Set: INCHES
Trans level: FL 180
Trans alt: 18000′
1. AUTHORIZATION REQUIRED. 2. GPS Required.
3. For uncompensated Baro-VNAV systems, procedure not authorized below -14°C (7°F) or above 42°C (107°F).
CANEK/UREXE/UTEGE TRANSITIONS
Chart Scale: 1 in=5 NM
RADAR required for procedure entry at UTEGE.
(IAF) UTEGE (RF required) (RNP 0.50)
JIMMI
FOR FINAL APPROACH SEE 12-22D
RW28L
HOBSI
CEPAV
SAKVY
JUBEN
MUFPI
ZABEV
TAYFI
(IF) OFTER
ROKTY
NEWKU
(IAF) EREXE (RNP 0.50)
(IAF) CANEK (RNP 0.50)
NOT FOR NAVIGATIONAL USE
Caldwell Industrial
Nampa Mun
R-3203D
CHANGES: VOLPE/MIT test chart.
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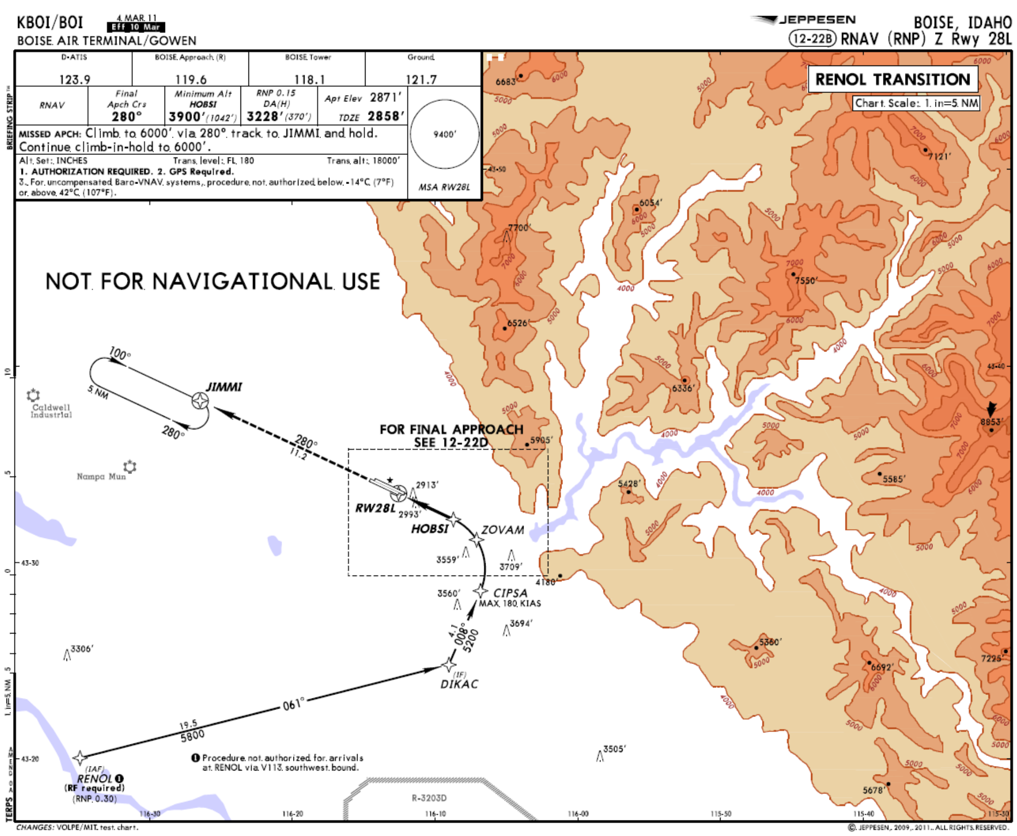
KBOI/BOI
4 MAR 11
Eff 10 Mar
BOISE AIR TERMINAL/GOWEN
JEPPESEN
BOISE, IDAHO
12-22B RNAV (RNP) Z Rwy 28L
D-ATIS 123.9
BOISE Approach (R) 119.6
BOISE Tower 118.1
Ground 121.7
RNAV
Final Apch Crs 280°
Minimum Alt HOBSI 3900′ (1042′)
RNP 0.15 DA(H) 3228′ (370′)
Apt Elev 2871′
TDZE 2858′
9400′
MSA RW28L
MISSED APCH: Climb to 6000′ via 280° track to JIMMI and hold. Continue climb-in-hold to 6000′.
Alt Set: INCHES
Trans level: FL 180
Trans alt: 18000′
1. AUTHORIZATION REQUIRED. 2. GPS Required.
3. For uncompensated Baro-VNAV systems, procedure not authorized below -14°C (7°F) or above 42°C (107°F).
RENOL TRANSITION
Chart Scale: 1 in=5 NM
NOT FOR NAVIGATIONAL USE
JIMMI
FOR FINAL APPROACH SEE 12-22D
RW28L
HOBSI
ZOVAM
CIPSA
MAX 180 KIAS
(IF) DIKAC
(IAF) RENOL (RF required) (RNP 0.30)
Procedure not authorized for arrivals at RENOL via V113 southwest bound.
Caldwell Industrial
Nampa Mun
R-3203D
CHANGES: VOLPE/MIT test chart.
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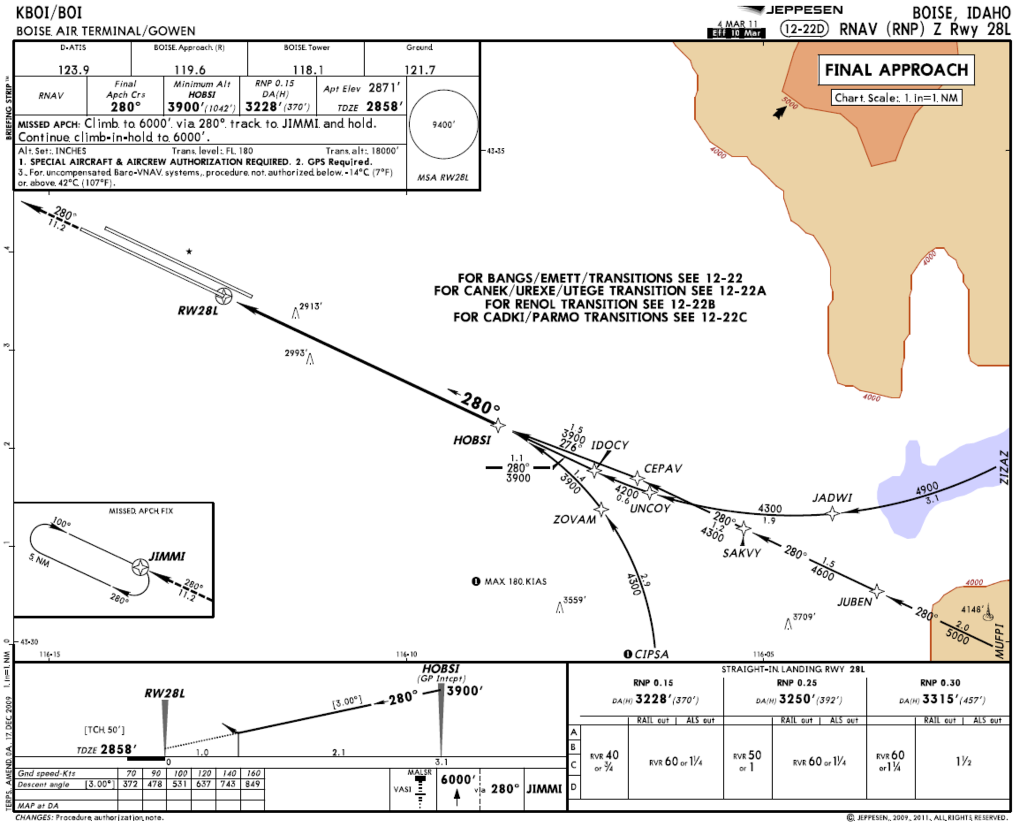
KBOI/BOI
BOISE AIR TERMINAL/GOWEN
JEPPESEN
BOISE, IDAHO
4 MAR 11
Eff 10 Mar
12-22D RNAV (RNP) Z Rwy 28L
D-ATIS 123.9
BOISE Approach (R) 119.6
BOISE Tower 118.1
Ground 121.7
RNAV
Final Apch Crs 280°
Minimum Alt HOBSI 3900′(1042′)
RNP 0.15 DA(H) 3228′(370′)
Apt Elev 2871′
TDZE 2858′
MISSED APCH: Climb to 6000′ via 280° track to JIMMI and hold. Continue climb-in-hold to 6000′.
Alt Set: INCHES
Trans level: FL 180
Trans alt: 18000′
1. SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED. 2. GPS Required.
3. For uncompensated Baro-VNAV systems, procedure not authorized below -14°C (7°F) or above 42°C (107°F).
9400′
MSA RW28L
FINAL APPROACH
Chart Scale: 1 in=1 NM
FOR BANGS/EMETT/TRANSITIONS SEE 12-22
FOR CANEK/UREXE/UTEGE TRANSITION SEE 12-22A
FOR RENOL TRANSITION SEE 12-22B
FOR CADKI/PARMO TRANSITIONS SEE 12-22C
RW28L
HOBSI
IDOCY
CEPAV
UNCOY
ZOVAM
JADWI
SAKVY
JUBEN
ZIZAZ
MUFPI
CIPSA
MAX 180 KIAS
MISSED APCH FIX
JIMMI
5 NM
STRAIGHT-IN LANDING RWY 28L
RNP 0.15 DA(H) 3228′(370′)
RNP 0.25 DA(H) 3250′(392′)
RNP 0.30 DA(H) 3315′(457′)
RVR 40 or 3/4
RVR 60 or 1¼
RVR 50 or 1
RVR 60 or 1¼
RVR 60 or 1¼
1½
Gnd speed-Kts 70 90 100 120 140 160
Descent angle [3.00°] 372 478 531 637 743 849
MAP at DA
HOBSI (GP Intcpt) 3900′
[TCH 50′]
TDZE 2858′
MALSR
VASI
6000′ via 280° JIMMI
CHANGES: Procedure authorization note.
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Bozeman RNAV (RNP) Z RWY 12

FAA

- Current

Modified

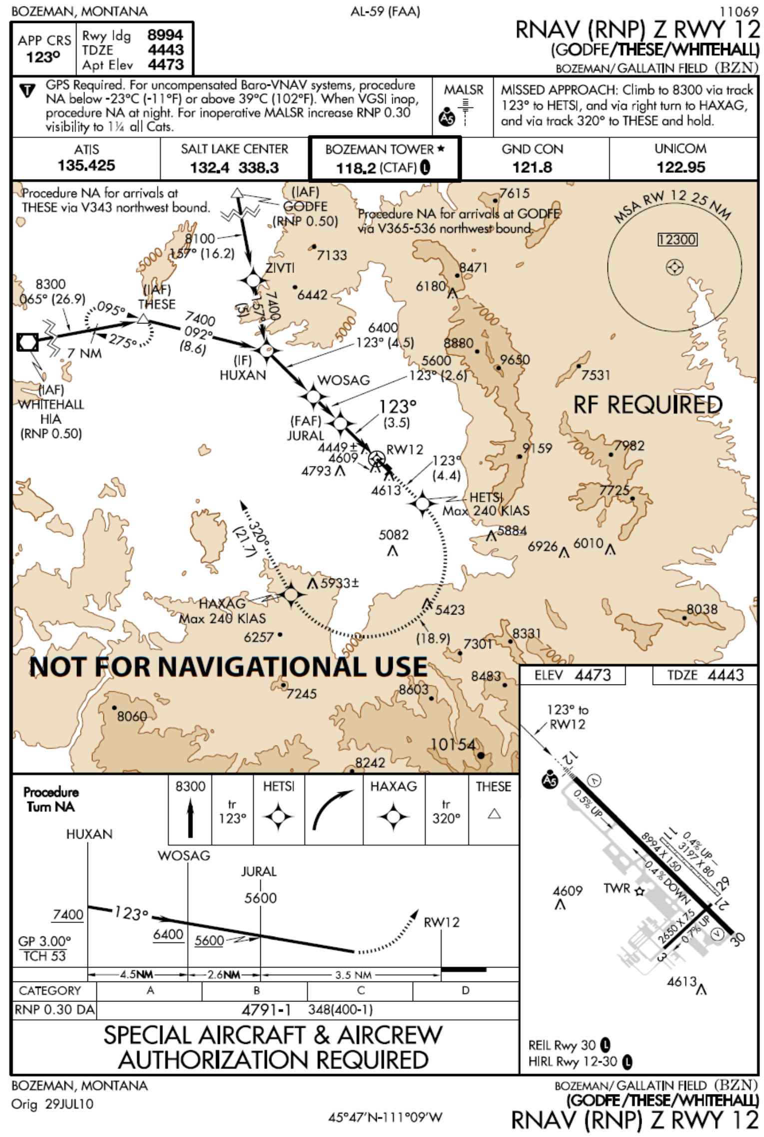
- GODFE/THESE/WHITEHALL
- JOXIT
- LIVINGSTON

Jeppesen

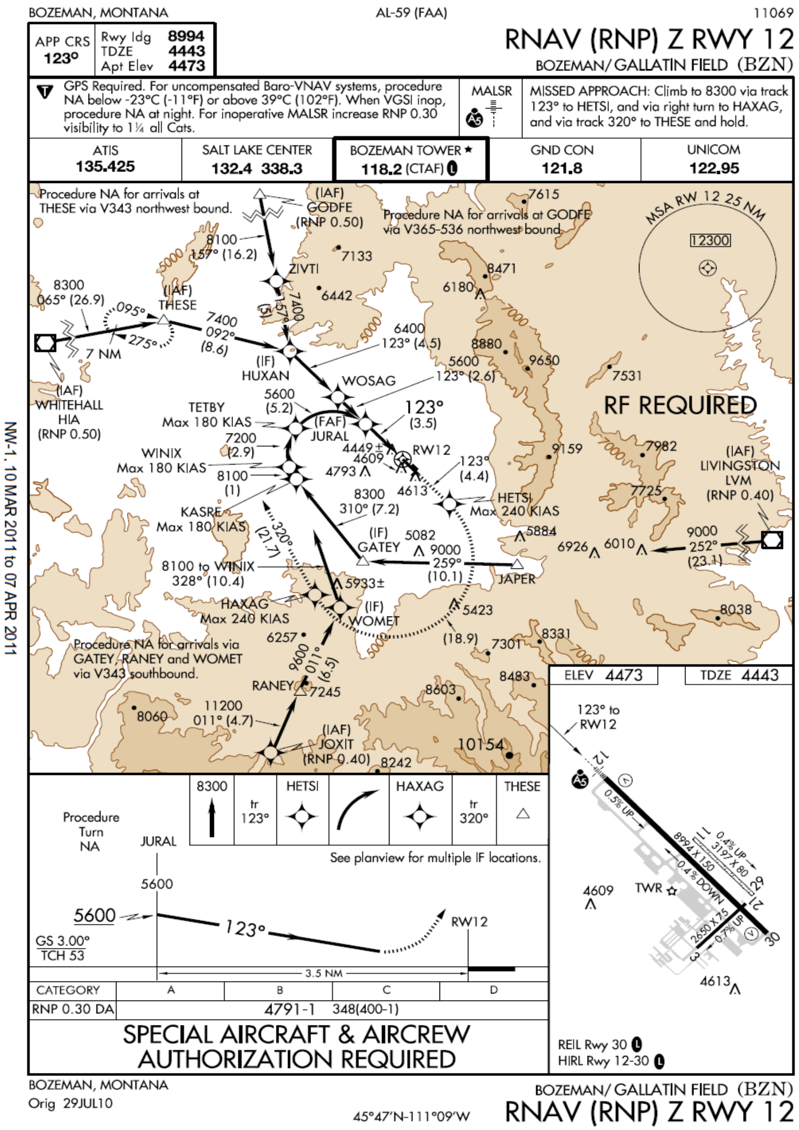
- Current

Modified

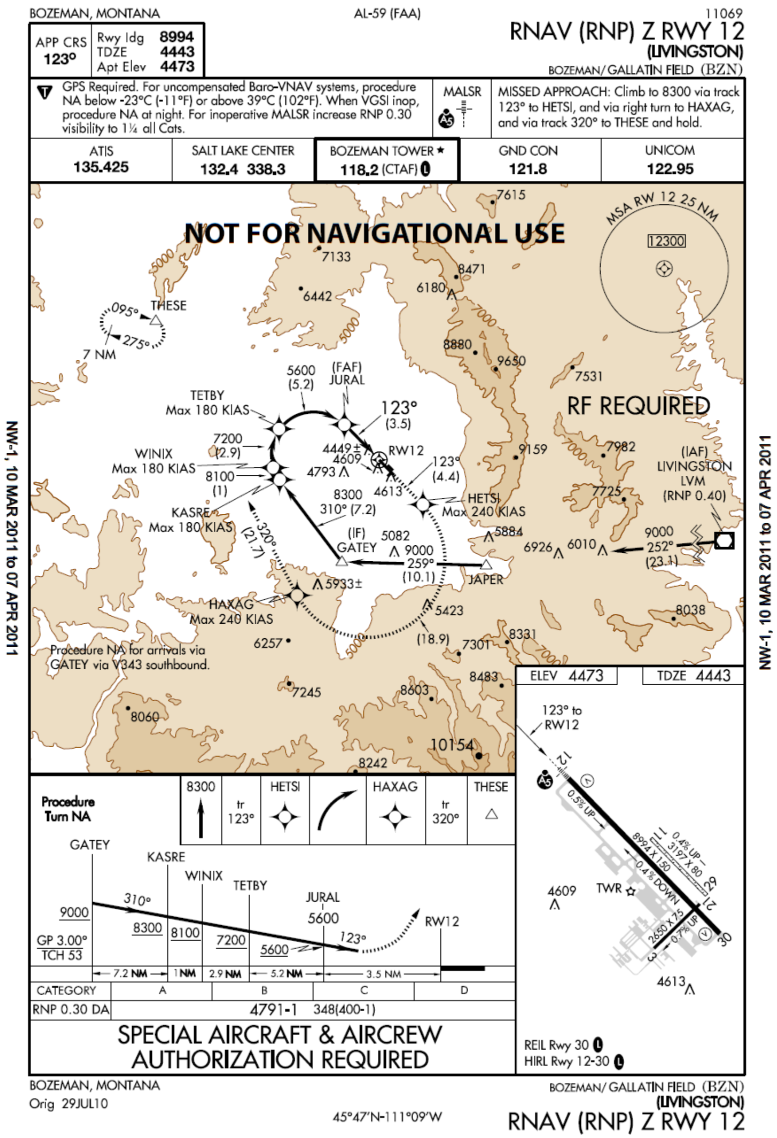
- GODFE/THESE/WHITEHALL
- JOXIT
- LIVINGSTON



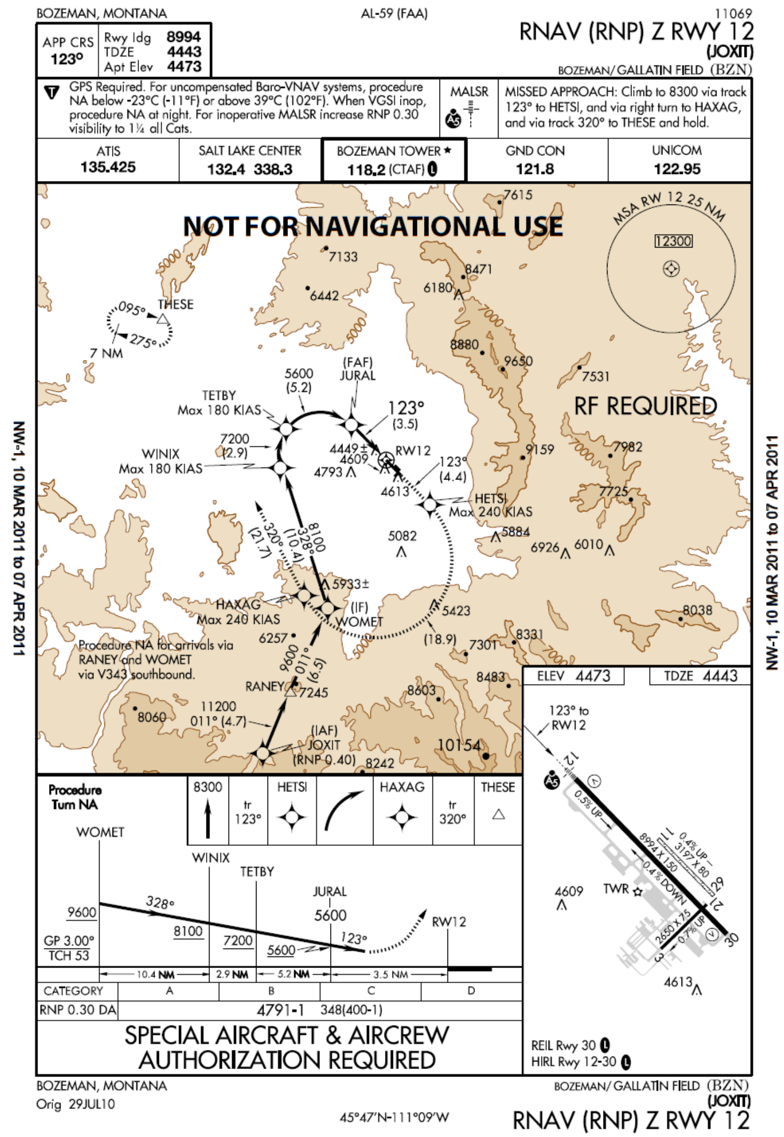
NW-1, 10 MAR 2011 to 07 APR 2011



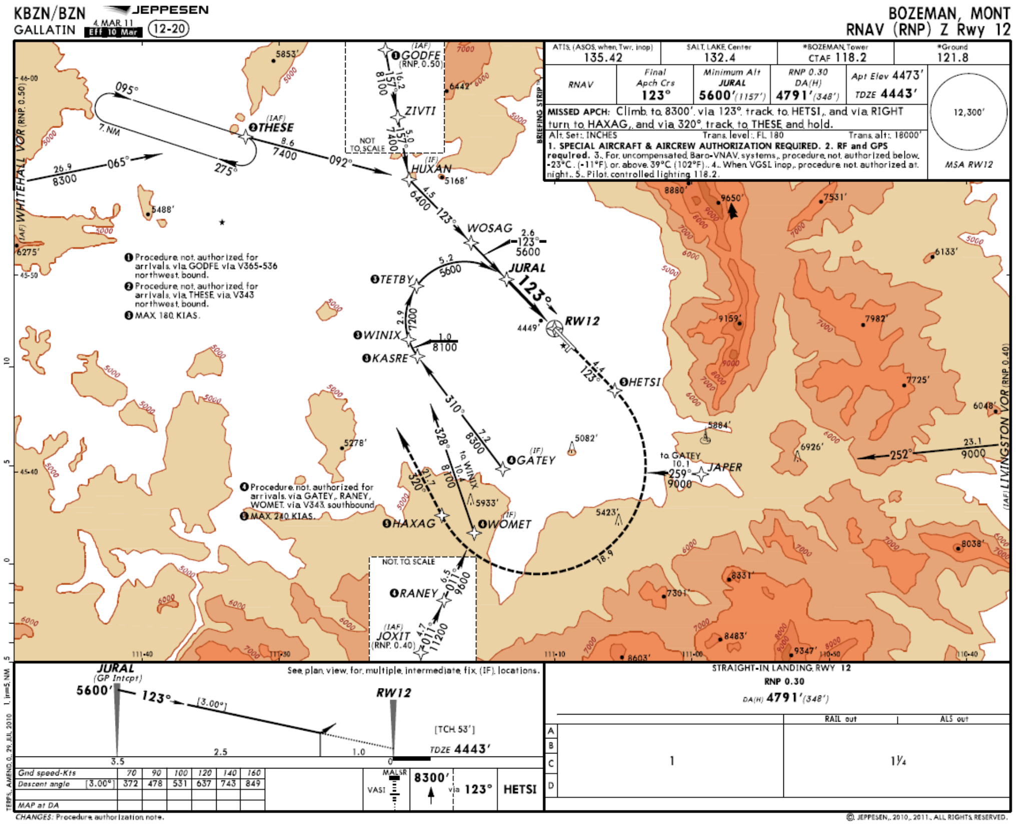
NW-1, 10 MAR 2011 to 07 APR 2011

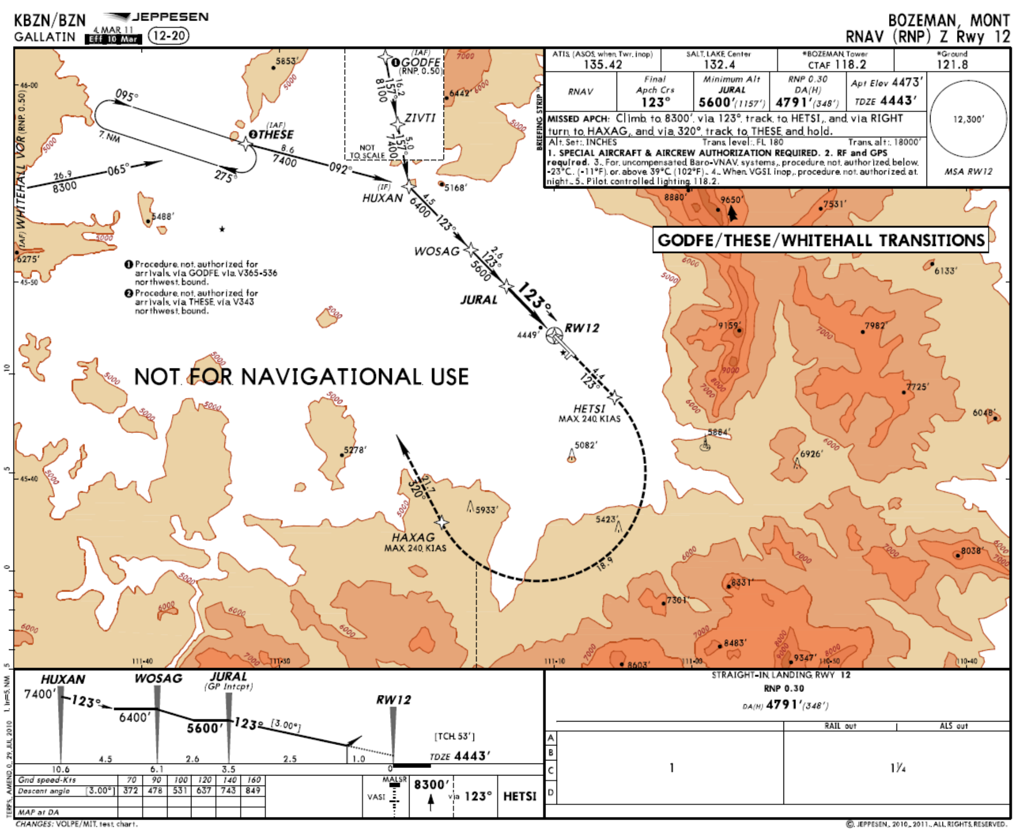


BOZEMAN, MONTANA
AL-59 (FAA)
11069
RNAV (RNP) Z RWY 12
(LIVINGSTON)
BOZEMAN/GALLATIN FIELD (BZN)
APP CRS 123°
Rwy ldg 8994
TDZE 4443
Apt Elev 4473
GPS Required. For uncompensated Baro-VNAV systems, procedure NA below -23°C (-11°F) or above 39°C (102°F). When VGSI inop, procedure NA at night. For inoperative MALSR increase RNP 0.30 visibility to 1¼ all Cats.
MALSR
MISSED APPROACH: Climb to 8300 via track 123° to HETSI, and via right turn to HAXAG, and via track 320° to THESE and hold.
ATIS 135.425
SALT LAKE CENTER 132.4 338.3
BOZEMAN TOWER ★ 118.2 (CTAF)
GND CON 121.8
UNICOM 122.95
NOT FOR NAVIGATIONAL USE
MSA RW 12 25 NM
12300
RF REQUIRED
(IAF) LIVINGSTON LVM (RNP 0.40)
Procedure NA for arrivals via GATEY via V343 southbound.
ELEV 4473
TDZE 4443
Procedure Turn NA
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED
CATEGORY A B C D
RNP 0.30 DA 4791-1 348(400-1)
REIL Rwy 30
HIRL Rwy 12-30
BOZEMAN, MONTANA
Orig 29JUL10
45°47'N-111°09'W
BOZEMAN/GALLATIN FIELD (BZN)
(LIVINGSTON)
RNAV (RNP) Z RWY 12
NW-1, 10 MAR 2011 to 07 APR 2011



BOZEMAN, MONTANA
AL-59 (FAA)
11069
RNAV (RNP) Z RWY 12
(JOXIT)
BOZEMAN/GALLATIN FIELD (BZN)
APP CRS 123°
Rwy ldg 8994
TDZE 4443
Apt Elev 4473
GPS Required. For uncompensated Baro-VNAV systems, procedure NA below -23°C (-11°F) or above 39°C (102°F). When VGSI inop, procedure NA at night. For inoperative MALSR increase RNP 0.30 visibility to 1¼ all Cats.
MALSR
MISSED APPROACH: Climb to 8300 via track 123° to HETSI, and via right turn to HAXAG, and via track 320° to THESE and hold.
ATIS 135.425
SALT LAKE CENTER 132.4 338.3
BOZEMAN TOWER ★ 118.2 (CTAF)
GND CON 121.8
UNICOM 122.95
NOT FOR NAVIGATIONAL USE
MSA RW 12 25 NM
12300
RF REQUIRED
(IAF) JOXIT (RNP 0.40)
Procedure NA for arrivals via RANEY and WOMET via V343 southbound.
ELEV 4473
TDZE 4443
Procedure Turn NA
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED
CATEGORY A B C D
RNP 0.30 DA 4791-1 348(400-1)
REIL Rwy 30
HIRL Rwy 12-30
BOZEMAN, MONTANA
Orig 29JUL10
45°47'N-111°09'W
BOZEMAN/GALLATIN FIELD (BZN)
(JOXIT)
RNAV (RNP) Z RWY 12
NW-1, 10 MAR 2011 to 07 APR 2011





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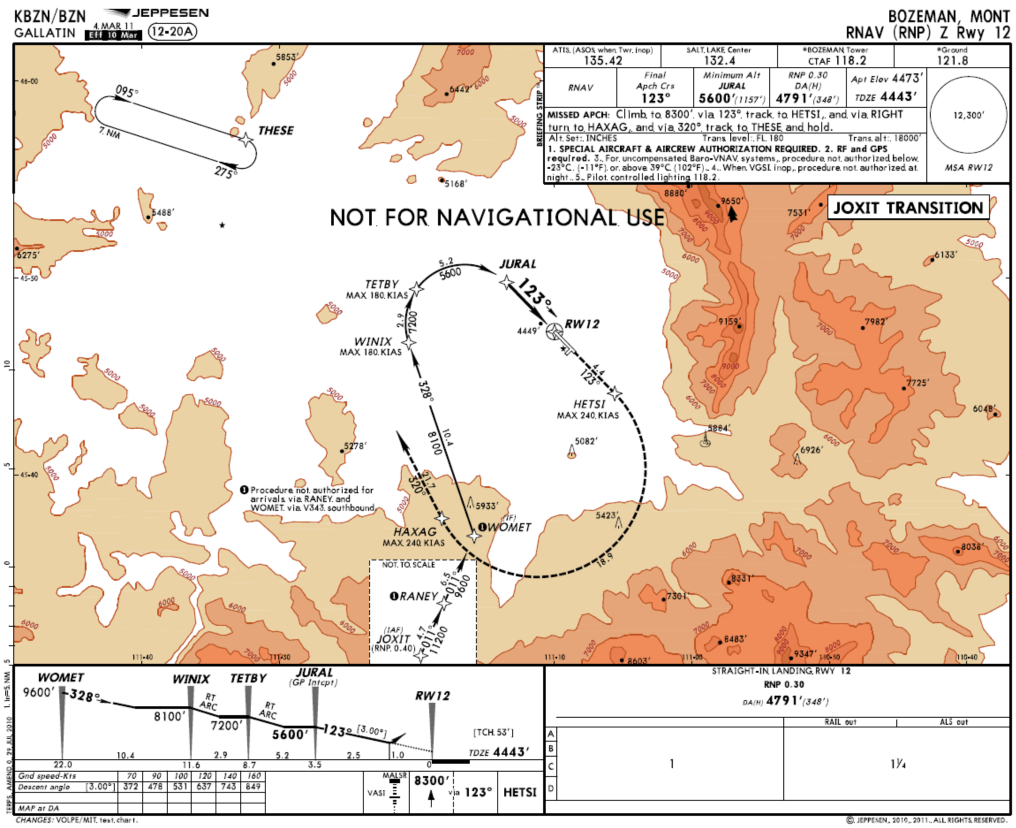
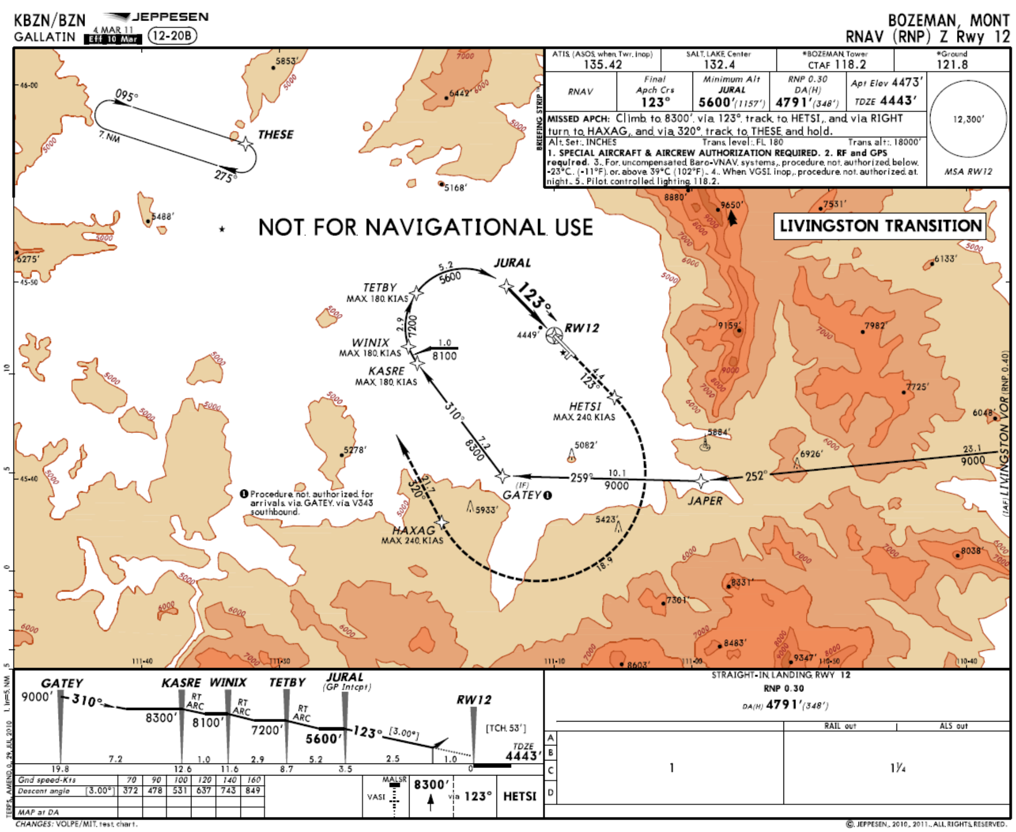


KBZN/BZN
GALLATIN
JEPPESEN
4 MAR 11 Eff 10 Mar
12-20A
BOZEMAN, MONT
RNAV (RNP) Z Rwy 12
NOT FOR NAVIGATIONAL USE
JOXIT TRANSITION
MISSED APCH: Climb to 8300' via 123° track to HETSI, and via RIGHT turn to HAXAG, and via 320° track to THESE and hold.
STRAIGHT-IN LANDING RWY 12
RNP 0.30



KBZN/BZN
GALLATIN
JEPPESEN
4 MAR 11 Eff 10 Mar
12-20B
BOZEMAN, MONT
RNAV (RNP) Z Rwy 12
NOT FOR NAVIGATIONAL USE
LIVINGSTON TRANSITION
MISSED APCH: Climb to 8300' via 123° track to HETSI, and via RIGHT turn to HAXAG, and via 320° track to THESE and hold.
STRAIGHT-IN LANDING RWY 12
RNP 0.30

Palm Springs RNAV (RNP) Y RWY 31L

FAA

- Current

Modified

- BALDI/PALM SPRINGS
- CLOWD/SBONO
- THERMAL

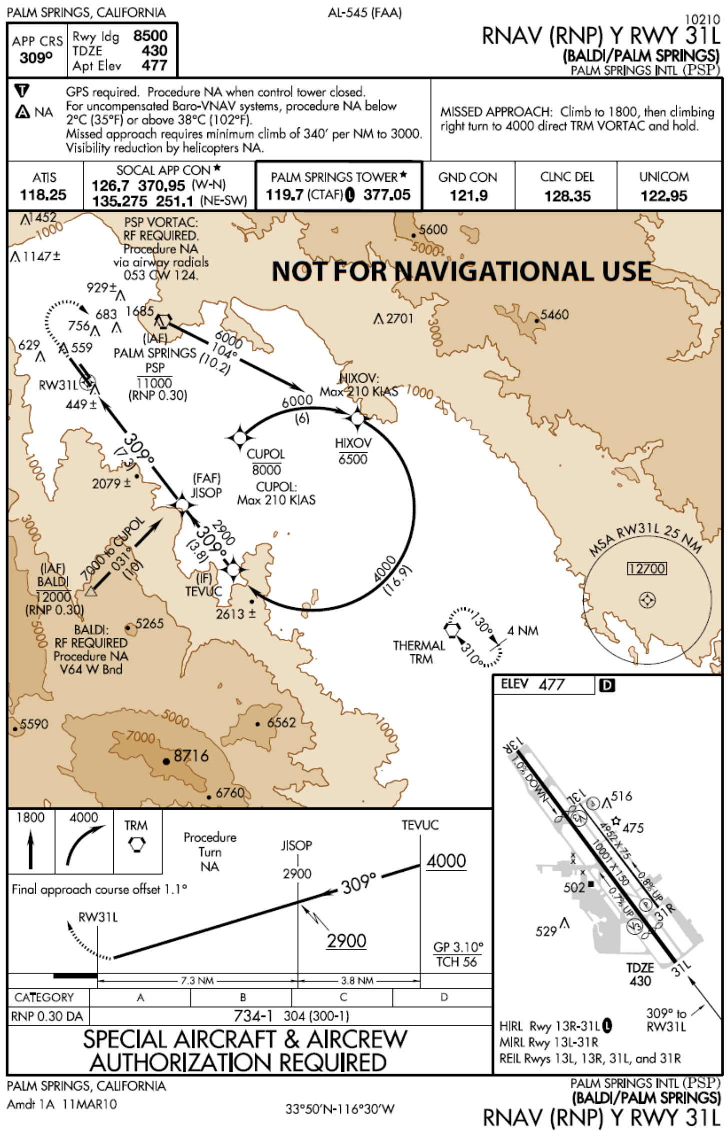
Jeppesen

- Current

Modified

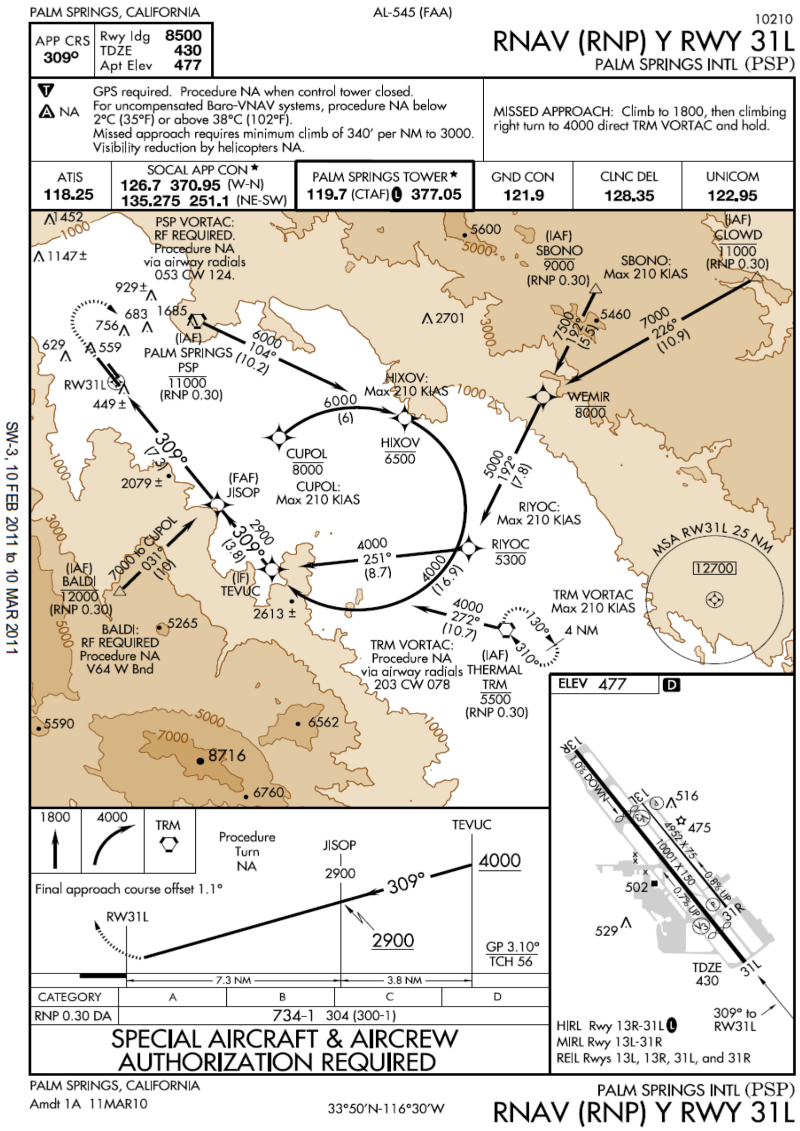
- BALDI/PALM SPRINGS
- CLOWD/SBONO
- THERMAL

SW-3, 10 MAR 2011 to 07 APR 2011

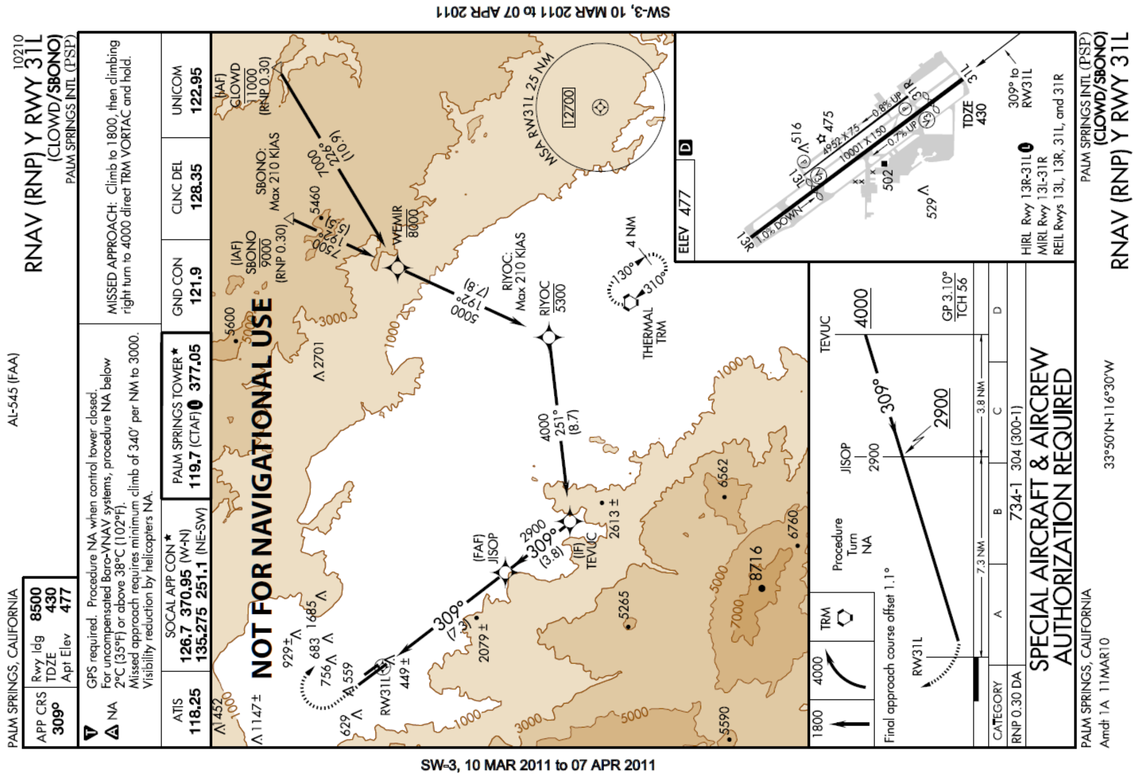


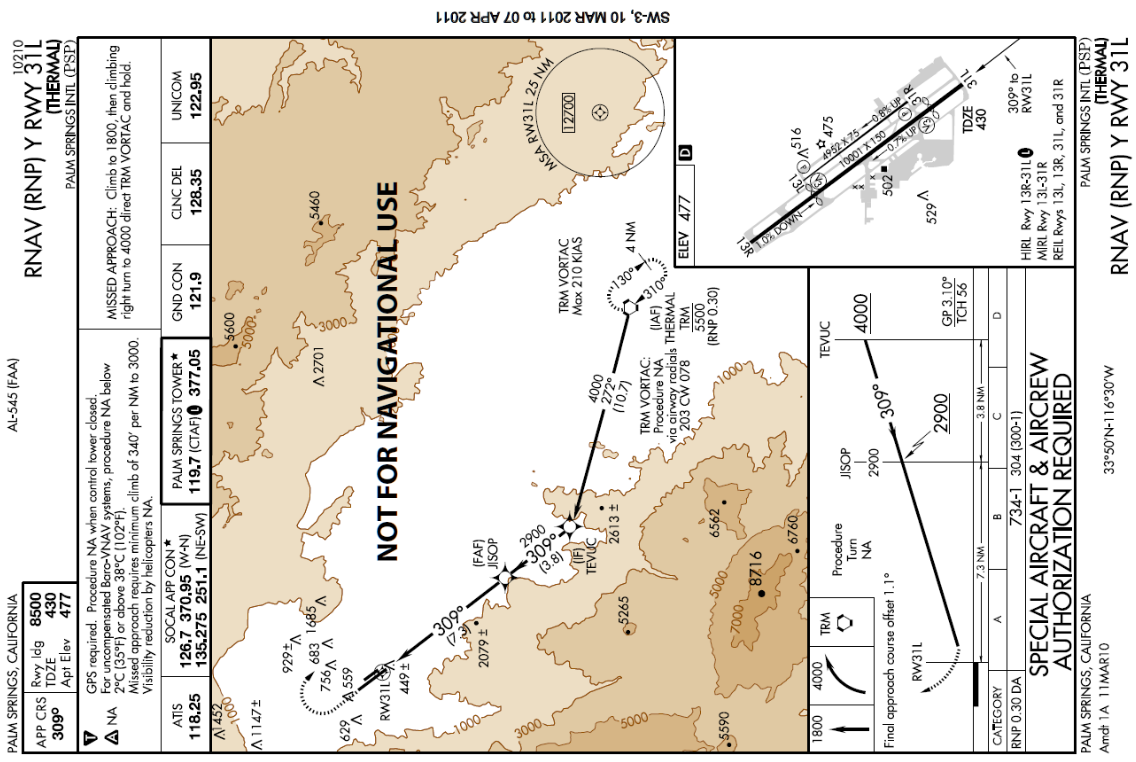
SW-3, 10 MAR 2011 to 07 APR 2011

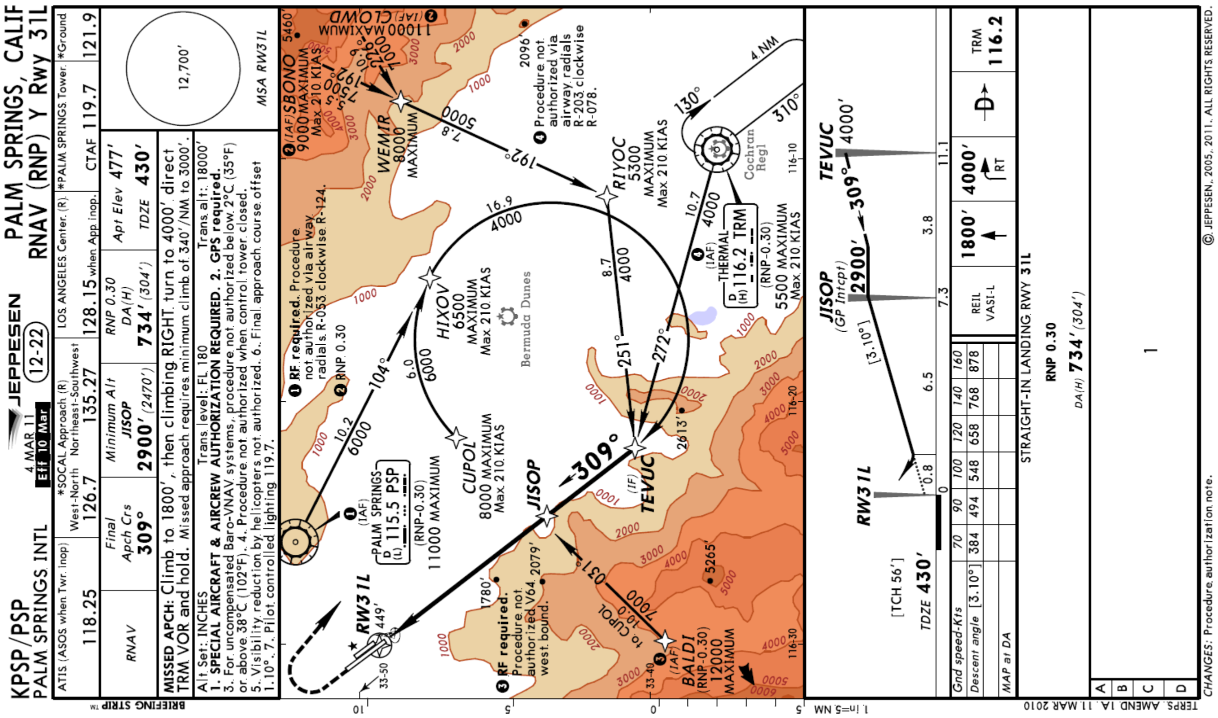
SW-3, 10 FEB 2011 to 10 MAR 2011



SW-3, 10 FEB 2011 to 10 MAR 2011


PALM SPRINGS, CALIFORNIA
AL-545 (FAA)
10210
RNAV (RNP) Y RWY 31L
(CLOWD/SBONO)
PALM SPRINGS INTL (PSP)
APP CRS 309°
Rwy ldg 8500
TDZE 430
Apt Elev 477
GPS required. Procedure NA when control tower closed. For uncompensated Baro-VNAV systems, procedure NA below 2°C (35°F) or above 38°C (102°F). Missed approach requires minimum climb of 340' per NM to 3000. Visibility reduction by helicopters NA.
MISSED APPROACH: Climb to 1800, then climbing right turn to 4000 direct TRM VORTAC and hold.
ATIS 118.25
SOCAL APP CON* 126.7 370.95 (W-N) 135.275 251.1 (NE-SW)
PALM SPRINGS TOWER* 119.7 (CTAF) 377.05
GND CON 121.9
CLNC DEL 128.35
UNICOM 122.95
NOT FOR NAVIGATIONAL USE
SBONO: Max 210 KIAS
RIYOC: Max 210 KIAS
MSA RW31L 25 NM
12700
ELEV 477
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED
CATEGORY
RNP 0.30 DA
734-1 304 (300-1)
HIRL Rwy 13R-31L
MIRL Rwy 13L-31R
REIL Rwys 13L, 13R, 31L, and 31R
PALM SPRINGS, CALIFORNIA
Amdt 1A 11MAR10
33°50'N-116°30'W
PALM SPRINGS INTL (PSP)
(CLOWD/SBONO)
RNAV (RNP) Y RWY 31L
SW-3, 10 MAR 2011 to 07 APR 2011


PALM SPRINGS, CALIFORNIA
AL-545 (FAA)
10210
RNAV (RNP) Y RWY 31L
(THERMAL)
PALM SPRINGS INTL (PSP)
APP CRS 309°
Rwy ldg 8500
TDZE 430
Apt Elev 477
GPS required. Procedure NA when control tower closed. For uncompensated Baro-VNAV systems, procedure NA below 2°C (35°F) or above 38°C (102°F). Missed approach requires minimum climb of 340' per NM to 3000. Visibility reduction by helicopters NA.
MISSED APPROACH: Climb to 1800, then climbing right turn to 4000 direct TRM VORTAC and hold.
ATIS 118.25
SOCAL APP CON* 126.7 370.95 (W-N) 135.275 251.1 (NE-SW)
PALM SPRINGS TOWER* 119.7 (CTAF) 377.05
GND CON 121.9
CLNC DEL 128.35
UNICOM 122.95
NOT FOR NAVIGATIONAL USE
TRM VORTAC Max 210 KIAS
TRM VORTAC: Procedure NA via airway radials 203 CW 078
MSA RW31L 25 NM
12700
ELEV 477
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED
CATEGORY
RNP 0.30 DA
734-1 304 (300-1)
HIRL Rwy 13R-31L
MIRL Rwy 13L-31R
REIL Rwys 13L, 13R, 31L, and 31R
PALM SPRINGS, CALIFORNIA
Amdt 1A 11MAR10
33°50'N-116°30'W
PALM SPRINGS INTL (PSP)
(THERMAL)
RNAV (RNP) Y RWY 31L
SW-3, 10 MAR 2011 to 07 APR 2011


KPSP/PSP
PALM SPRINGS INTL
PALM SPRINGS, CALIF
RNAV (RNP) Y Rwy 31L
JEPPESEN
4 MAR 11
Eff 10 Mar
12-22
CHANGES: Procedure authorization note.
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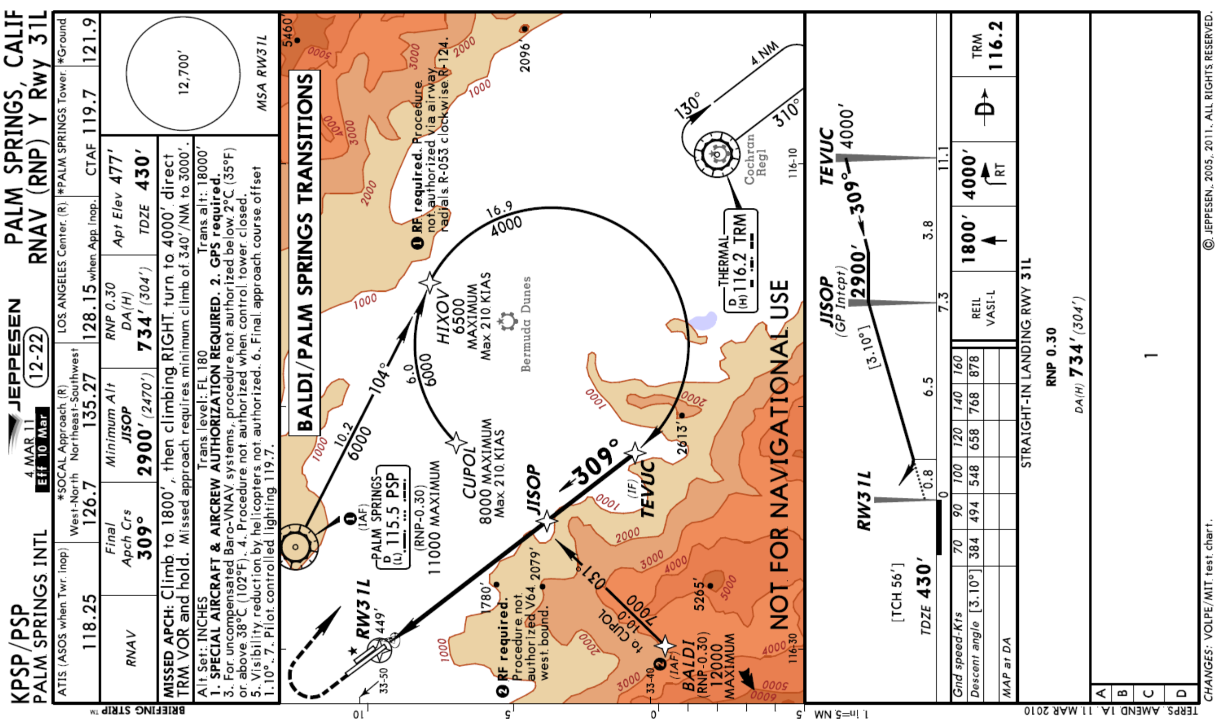
KPSP/PSP
PALM SPRINGS INTL
PALM SPRINGS, CALIF
RNAV (RNP) Y Rwy 31L
JEPPESEN
4 MAR 11
Eff 10 Mar
12-22
BALDI/PALM SPRINGS TRANSITIONS
NOT FOR NAVIGATIONAL USE
CHANGES: VOLPE/MIT test chart.
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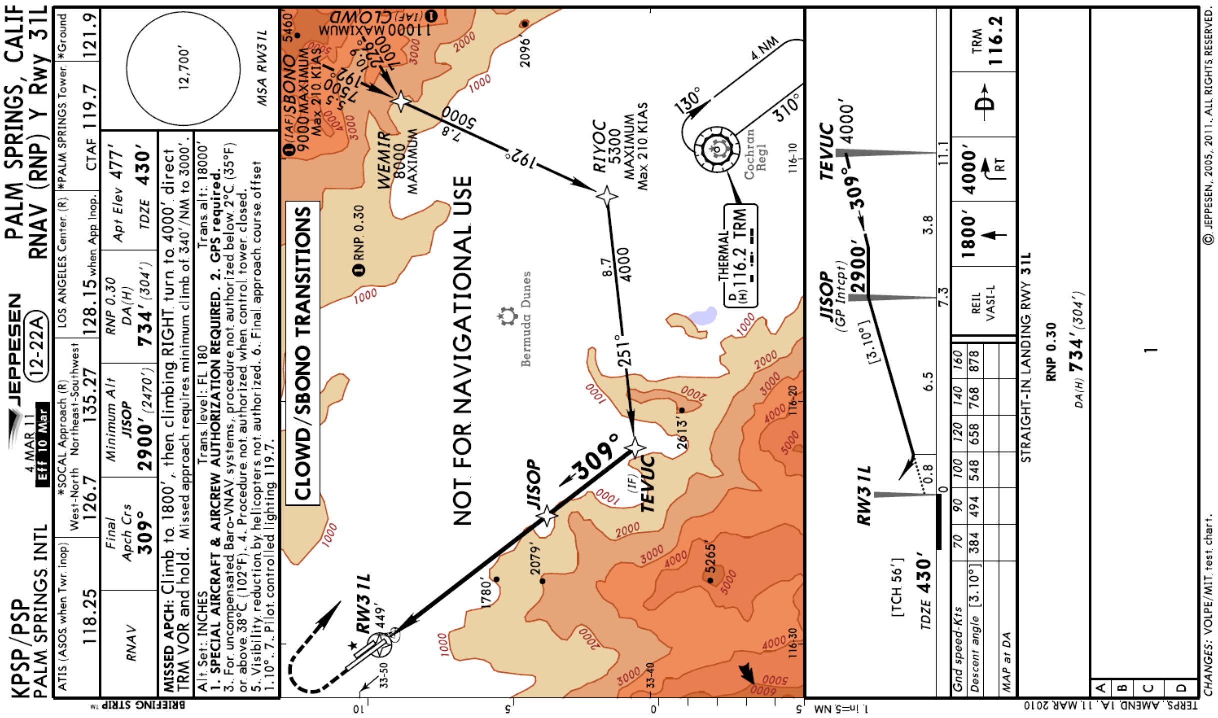
KPSP/PSP
PALM SPRINGS INTL
JEPPESEN
4 MAR 11 Eff 10 Mar
12-22A
PALM SPRINGS, CALIF
RNAV (RNP) Y Rwy 31L
MISSED APCH: Climb to 1800', then climbing RIGHT turn to 4000' direct TRM VOR and hold. Missed approach requires minimum climb of 340'/NM to 3000'.
CLOWD/SBONO TRANSITIONS
NOT FOR NAVIGATIONAL USE
STRAIGHT-IN LANDING RWY 31L
RNP 0.30
DA(H) 734' (304')
CHANGES: VOLPE/MIT test chart.
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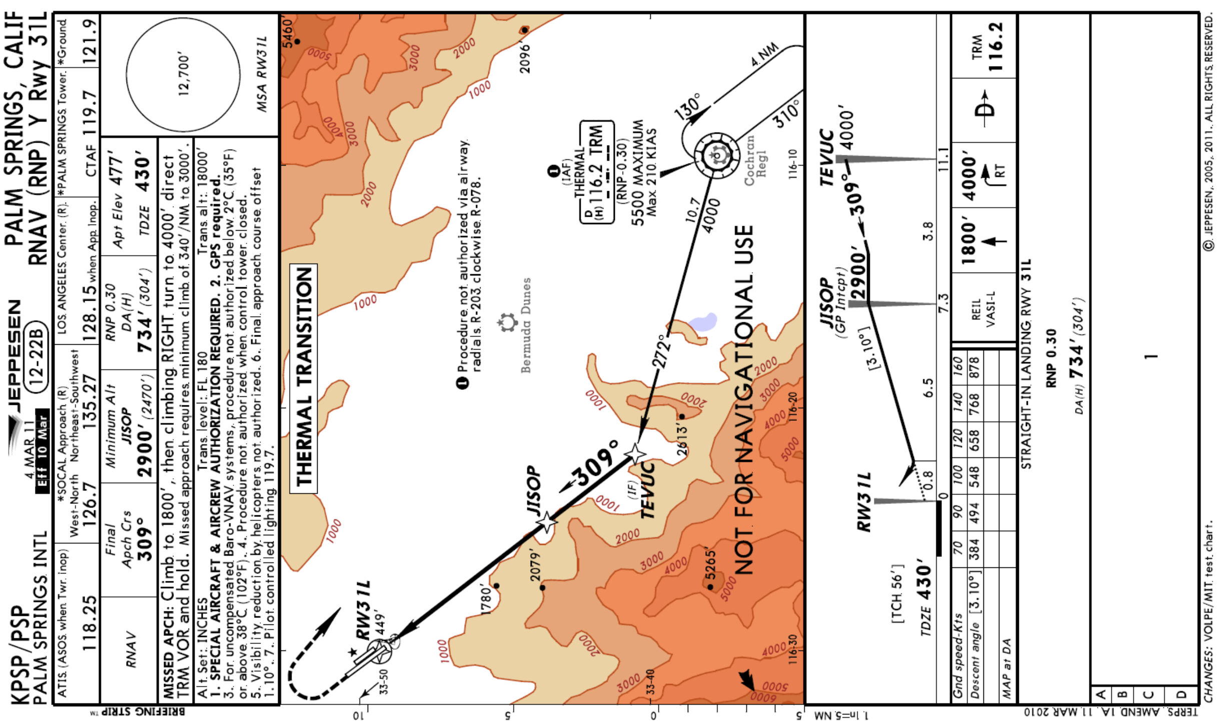
KPSP/PSP
PALM SPRINGS INTL
JEPPESEN
4 MAR 11 Eff 10 Mar
12-22B
PALM SPRINGS, CALIF
RNAV (RNP) Y Rwy 31L
MISSED APCH: Climb to 1800', then climbing RIGHT turn to 4000' direct TRM VOR and hold. Missed approach requires minimum climb of 340'/NM to 3000'.
THERMAL TRANSITION
Procedure not authorized via airway radials R-203 clockwise R-078.
NOT FOR NAVIGATIONAL USE
STRAIGHT-IN LANDING RWY 31L
RNP 0.30
DA(H) 734' (304')
CHANGES: VOLPE/MIT test chart.
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Appendix D: Chart Element Counts and Response Times by Procedure

The table below shows the element count and average response times for each chart image (current and modified) for departures and approaches in the study. The response times in the first table are across only questions for which answers were in the graphic section of the chart that was modified.

Type	Airport	Chart Page	Number of Questions	Element Count	Response Time (sec) (outliers excluded)
Approaches	BOI	Current	10	142	19.51
		BANGS/EMETT	2	50	13.38
		CADKI/PARMO	2	30	14.76
		CANEK/EREXE/UTEGE	4	51	12.79
		RENOL	2	22	8.39
	PSP	Current	7	61	11.94
		BALDI/PALM SPRINGS	3	32	11.94
		CLOWD/SBONO	1	30	9.20
		THERMAL	1	15	7.89
	BZN	Current	6	80	16.91
		JOXIT	1	27	8.40
		LIVINGSTON	2	32	11.64
		GODFE/THESE/WHITEHALL	3	30	11.43
Departures	DFW	Current	6	92	13.96
		17C/R, 18L/R	3	50	9.64
		35L/C, 36L/R	3	65	13.69
	LAS	Current	8	86	14.23
		1L/R, 19L/R	3	54	9.96
		7L/R, 25L/R	5	67	12.40
	SLC	Current	8	149	16.15
		HAYDEN/MEEKER/MYTON	3	95	14.02
		HOLTR	3	51	11.50
		ROCK SPRINGS	2	51	10.68

This table shows element counts and average response time across approach chart questions for which the answers were outside of the plan-view area (i.e., in unmodified areas of the chart).

Airport	Chart Page	Element Count	Response Time (sec)
BOI	Current, question 1	142	10.38
	Current, question 2	142	5.16
	CADKI/PARMO	30	5.78
	BANGS/EMETT	50	4.72
PSP	CLOWD/SBONO, question 1	30	10.94
	CLOWD/SBONO, question 2	30	6.23
BZN	Current, question 1	80	5.73
	Current, question 2	80	6.85
	JOXIT	27	8.01
	GODFE/THESE/WHITEHALL	30	6.51

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