

X-PLANE

AIRPORT DATA (APT.DAT) FILE SPECIFICATION

VERSION 850

REVISION HISTORY

28 April 2009	Spec converted to this new format to support new web site (http://data.x-plane.com).
12 July 2009	Minor typos fixed
14 July 2009	Minor errors in helipad spec fixed
6 Sept 2009	Added clearer examples of taxiway signs (submitted by Donald Good – thanks!)
1 Feb 2011	Clarified definitions of runway ends and thresholds

APPLICABILITY

This specification (APT.DAT 850) is supported in X-Plane 8.50 and later. However, the significant new feature set in this file version was not *fully* supported until the release of X-Plane 8.61.

The prior specification for airport data was APT.DAT 810, which is recommended for X-Plane 8.10 – 8.60.

SUPPORT FOR DEPRECATED FILE FORMATS

The deprecated file specification (APT.DAT 810) is still supported. A large quantity of custom airport data exists only in this format. So airports defined according to this specification (APT.DAT 810) can be included in a file otherwise complying with the APT.DAT 850 specification.

The specification for APT.DAT 810 is available at <http://data.x-plane.com>

OVERVIEW & SCOPE

This specification defines core airport data for X-Plane. This includes the locations of runways, taxiway and apron pavement, basic airport ‘furniture’ (VASI/PAPIs, windsocks, light beacons and taxiway signage) and communications frequencies. It also includes attributes for each of these features to fully describe them (eg. it includes runway surface type, runway markings, taxiway lighting and markings, approach lighting, taxiway sign text, etc).

This specification does not include scenery objects (such as buildings, static aeroplanes or underlying terrain textures).

BASIC CONCEPTS

- Latitudes and longitudes are described in a decimal notation (eg. 20.12345678).
 - A latitude of 50 degrees 30 minutes south would be defined as -50.50000000
- North latitudes and east longitudes are positive. South latitudes and west longitudes are negative.
- All headings are referenced to true north (not magnetic north).

FILE CHARACTERISTICS

The apt.dat files are plain text files:

- Fields in the data can be separated by one or more white space characters (space, tab).
 - By default, the files are generated so that columns of data are consistently aligned, but this is not required.
- Blank rows are permitted and are helpful to differentiate between airports.

FILE STRUCTURE

It is recommended that all airports be created in the free WorldEditor (“WED”) tool. This will ensure that all structural requirements listed here for airport data are met.

In common with most other X-Plane data file specification, header rows of data define the origin (“I” = PC or “A” = Mac) of a particular copy of a file, and define the file specification version. The file specification may be followed by a reference to a sequential release data cycle and build number for the data, and a copyright message:

```
I
850 Version - data cycle 2009.01, build 20081054, metadata AptXP850. Copyright © 2009, Robin A. Peel (robin@xsquawkbox.net)...
```

The complete copyright message must be left intact if you redistribute this data. The GNU GPL (general public License) under which this data is released is designed to encourage modifications, enhancements and redistribution, even in commercial derivative products. More details about this license are available on my website (<http://data.x-plane.com>).

Subsequent rows of data follow a hierarchical structure:

- Each row of data has a numeric 'row code' as its first field, to define its content.
- The top level of this hierarchy defines an individual airport, defined by an airport header row (a row code of '1', '16' or '17').
- Subsequent rows define elements of an airport:
 - **Runways** (including helipads) follow the airport header row (one row per runway).
 - **Pavement (taxiway/apron) definitions** have a header row followed by an ordered list of nodes that define its boundaries:
 - Each pavement definition must each have a single boundary with no overlaps with itself.
 - Nodes on this outer boundary must be defined in a counter-clockwise direction.
 - Boundaries must be terminated with a node with a row code '113' or '114'.
 - Pavement definitions may overlap with another pavement chunk. But this is not recommended – instead consider precise alignment of adjacent features by 'snapping' nodes to identical locations in World Editor (WED).
 - A pavement definition can never overlap with itself.
 - The sequencing of the pavement definitions is the layering in which they will be rendered in X-Plane, top-down. So the last piece of pavement in the file will be rendered underneath any others with which it overlaps.
 - **Holes** can be defined for pavement (through which the underlying terrain texture will show):
 - Hole boundaries should follow the termination of the pavement definition in which the hole occurs (starting with a row type '111' or '112').
 - Hole boundaries are defined in a clockwise direction (ie, *opposite* direction to the boundary nodes).
 - Hole boundaries must form a closed loop (ie. must terminate with a row code '113' or '114').
 - Each pavement definition can have zero, one or multiple hole boundaries.
 - Hole boundaries must be contained within the outer boundary of the pavement definition.
 - Holes cannot overlap each other.
 - After creating a hole boundary, it can be 'filled' with a new pavement chunk (probably using a different surface type).
 - **Linear features** also have a header row followed by an ordered list of nodes that define the line:
 - Linear features can be closed loops (terminating in a node of type '113' or '114') or just strings (terminating with '115' or '116').
 - An **airport boundary** is defined with nodes in a counter-clockwise direction. A boundary can contain holes (see above) and must form a closed loop (terminating in a node of type '113' or '114').
 - **Other airport features** are defined with one row for each feature.

The file is terminated by a '99':

99

ROW CODES

Each row of data begins with an integer code that defines the type of data:

Row Code	Meaning	Comment
1	Land airport header	
16	Seaplane base header	
17	Helicopter header	
100	Runway	
101	Water runway	
102	Helipad	
110	Pavement (taxiway or ramp) header	Must form a closed loop
120	Linear feature (painted line or light string) header	Can form closed loop or simple string
130	Airport boundary header	Must form a closed loop
111	Node	All nodes can also include a "style" (line or lights)
112	Node with Bezier control point	Bezier control points define smooth curves
113	Node with implicit close of loop	Implied join to first node in chain
114	Node with Bezier control point, with implicit close of loop	Implied join to first node in chain
115	Node terminating a string (no close loop)	No "styles" used
116	Node with Bezier control point, terminating a string (no close loop)	No "styles" used
14	Airport viewpoint	One or none for each airport
15	Aeroplane startup location	Zero, one or many for each airport
18	Airport light beacon	One or none for each airport
19	Windsock	Zero, one or many for each airport
20	Taxiway sign (inc. runway distance-remaining signs)	Zero, one or many for each airport
21	Lighting object (VASI, PAPI, Wig-Wag, etc.)	Zero, one or many for each airport
50 – 56	Communication frequencies	Zero, one or many for each airport

EXAMPLE DATA

Here is some example data for KBFI. It is not real and is very incomplete, but it illustrates examples of most types of data found in an apt.dat file. This data includes an airport header, runway, water runway, helipad, PAPI, taxiway definition, painted line, viewpoint, startup location, light beacon, windsock, taxiway sign and an ATC communications frequency:

```
1 21 1 0 KBFI Boeing Field King Co Intl
100 29.87 1 0 0.15 0 2 1 13L 47.53801700 -122.30746100 73.15 0.00 2 0 0 1 31R 47.52919200 -122.30000000 110.95 0.00 2 0 0 1
101 49 1 08 35.04420900 -106.59855700 26 35.04420911 -106.59855711
102 H1 47.53918248 -122.30722302 2.00 10.06 10.06 1 0 0 0.25 0
21 47.53666659 -122.30585255 2 150.28 3.30 13L PAPI-2L
110 1 0.25 150.29 A2 Exit
111 47.53770968 -122.30849802
111 47.53742819 -122.30825844 3
112 47.53752190 -122.30826710 47.53757385 -122.30824831 3 102
114 47.53768630 -122.30834929 47.53768690 -122.30838150 3 102
120 Line B1
111 47.53969864 -122.31276189 51
111 47.53977825 -122.31255145 1
115 47.54002296 -122.31189878
14 47.52917900 -122.30434900 100 0 ATC Tower
15 47.52926674 -122.29919589 304.16 A8 Run Up
18 47.52920400 -122.30412800 1 BCN
19 47.53900921 -122.30868700 1 WS
20 47.54099177 -122.31031317 235.71 0 2 {@L}A1{@R}31R-13L
50 12775 ATIS
```

DEFINITION OF DATA FIELDS

Each column in each row code is defined below, using the example data from KBFI shown above. Note that:

- Some row codes store data in an identical specification, and these have been grouped together in the table below.
- The specification aims to be consistent. For example, the format or latitudes and longitudes is always the same, and all headings/orientations are defined as true (not magnetic) degrees.

Row	Meaning <i>Example value</i>	Comment <i>Explanation</i>	<i>Valid values</i>
1	Land airport header	Row codes 1, 16 and 17 share a common format (see below)	
16	Seaplane base header	Row codes 1, 16 and 17 share a common format (see below)	
17	Heliport header	Row codes 1, 16 and 17 share a common format (see below)	
	1	Row code for an airport, seaplane base or heliport	1, 16 or 17
	21	Elevation of airport in feet above mean sea level (AMSL)	
	1	Flag for control tower (used only in the X-Plane ATC system)	0=no ATC tower, 1=has ATC tower
	0	Deprecated. Use default value ("0")	Use 0
	KBFI	Airport ICAO code. If no ICAO code exists, use FAA code (USA only)	Maximum four characters. Must be unique.
	Boeing Field King Co ...	Airport name. May contain spaces. Do not use special (accented) characters	Text string (up to 40 characters)
100	Land Runway		
	100	Row code for a land runway (the most common)	100
	29.87	Width of runway in metres	Two decimal places recommended. Must be >= 1.00
	1	Code defining the surface type (concrete, asphalt, etc)	Integer value for a Surface Type Code
	0	Code defining a runway shoulder surface type	0=no shoulder, 1=asphalt shoulder, 2=concrete shoulder
	0.15	Runway smoothness (not used by X-Plane yet)	0.00 (smooth) to 1.00 (very rough). Default is 0.25
	0	Runway centre-line lights	0=no centerline lights, 1=centre line lights
	2	Runway edge lighting (also implies threshold lights)	0=no edge lights, 2=medium intensity edge lights
	1	Auto-generate distance-remaining signs (turn off if created manually)	0=no auto signs, 1=auto-generate signs
	<i>The following fields are repeated for each end of the runway</i>		
	13L	Runway number (eg. "31R", "02"). Leading zeros are required.	Two to three characters. Valid suffixes: "L", "R" or "C" (or blank)
	47.53801700	Latitude of runway end (on runway centerline) in decimal degrees	Eight decimal places supported
	-122.30746100	Longitude of runway end (on runway centerline) in decimal degrees	Eight decimal places supported
	73.15	Length of displaced threshold in metres (this is included in implied runway length) A displaced threshold will always be <u>inside</u> (between) the two runway ends	Two decimal places (metres). Default is 0.00
	0.00	Length of overrun/blast-pad in metres (<u>not</u> included in implied runway length)	Two decimal places (metres). Default is 0.00
	2	Code for runway markings (Visual, non-precision, precision)	Integer value for Runway Marking Code
	0	Code for approach lighting for this runway end	Integer value for Approach Lighting Code
	0	Flag for runway touchdown zone (TDZ) lighting	0=no TDZ lighting, 1=TDZ lighting
	1	Code for Runway End Identifier Lights (REIL)	0=no REIL, 1=omni-directional REIL, 2=unidirectional REIL
101	Water runway		
	101	Row code for a water runway	101
	49	Width of runway in metres	Two decimal places recommended. Must be >= 1.00
	1	Flag for perimeter buoys	0=no buoys, 1=render buoys
	<i>The following fields are repeated for each end of the water runway</i>		
	08	Runway number. Not rendered in X-Plane (it's on water!)	Valid suffixes are "L", "R" or "C" (or blank)
	35.04420911	Latitude of runway end (on runway centerline) in decimal degrees	Eight decimal places supported
	-106.59855711	Longitude of runway end (on runway centerline) in decimal degrees	Eight decimal places supported

Row	Meaning <i>Example value</i>	Comment <i>Explanation</i>	<i>Valid values</i>
102	Helipad		
	102	Row code for a helipad	101
	H1	Designator for a helipad. Must be unique at an airport.	Usually "H" suffixed by an integer (eg. "H1", "H3")
	47.53918248	Latitude of helipad centre in decimal degrees	Eight decimal places supported
	-122.30722302	Longitude of helipad centre in decimal degrees	Eight decimal places supported
	2.00	Orientation (true heading) of helipad in degrees	Two decimal places recommended
	10.06	Helipad length in metres	Two decimal places recommended (metres), must be >=1.00
	10.06	Helipad width in metres	Two decimal places recommended (metres), must be >= 1.00
	1	Helipad surface code	Integer value for a Surface Type Code
	0	Helipad markings	0 (other values not yet supported)
	0	Code defining a helipad shoulder surface type	0=no shoulder, 1=asphalt shoulder, 2=concrete shoulder
	0.25	Helipad smoothness (not used by X-Plane yet)	0.00 (smooth) to 1.00 (very rough). Default is 0.25
	0	Helipad edge lighting	0=no edge lights, 1=yellow edge lights
110	Pavement (taxiways)	Defines an arbitrary pavement shape	
	110	Row code for a pavement chunk header (must be followed by a set of nodes)	110
	1	Code defining the surface type (concrete, asphalt, etc)	Integer value for a Surface Type Code
	0.25	Runway smoothness (not used by X-Plane yet)	0.00 (smooth) to 1.00 (very rough). Default is 0.25
	150.29	Orientation (true degrees) of pavement texture 'grain'	Two decimal places recommended
	A2 Exit	Description of pavement chunk (not used by X-Plane)	Text string
120	Linear feature	Painted surface markings & light strings	
130	Airport boundary	Boundary for future terrain 'flattening'	
	120	Row code for a linear feature or airport boundary	120 or 130
	Line B1	Description of feature or boundary (not used by X-Plane)	Text string

Row	Meaning <i>Example value</i>	Comment <i>Explanation</i>	<i>Valid values</i>
111	Node	Node (plain)	
112	Node	Node with Bezier control point	
113	Node	Node (close loop), to close boundary	
114	Node	Node (close loop) with Bezier control point	
115	Node	Node (end) to terminate a line	
116	Node	Node (end) with Bezier control point	
	112	Row code for a node. First node must follow an appropriate header row	111 thru 116
	47.53752190	[All nodes] Latitude of node in decimal degrees	Eight decimal places supported
	-122.30826710	[All nodes] Longitude of node in decimal degrees	Eight decimal places supported
	47.53757385	[112, 114, 116 only] Latitude of Bezier control point in decimal degrees	Eight decimal places supported. Ignore for 111, 113, 115
	-122.30824831	[112, 114, 116 only] Latitude of Bezier control point in decimal degrees	Eight decimal places supported. Ignore for 111, 113, 115
	3	[Not for 115 or 116] Code for painted line type on line segment starting at this node	Integer Line Type Code . Not for 115 or 116
	102	[Not for 115 or 116] Code for lighting on line segment starting at this node	Integer Line Type Code . Not for 115 or 116
14	Viewpoint	Maximum of <u>one</u> viewpoint for each airport	
	14	Row code for a viewpoint	14
	47.52917900	Latitude of viewpoint in decimal degrees	Eight decimal places supported
	-122.30434900	Longitude of viewpoint in decimal degrees	Eight decimal places supported
	100	Height (in feet) of viewpoint above ground level	Integer
	0	Code deprecated. Use '0'	0
	ATC Tower	Name of viewpoint (not used by X-Plane)	Descriptive text string (optional)
15	Startup location	Startup locations for airplanes at an airport	
	15	Row code for a startup location	15
	47.52926674	Latitude of startup location in decimal degrees	Eight decimal places supported
	-122.29919589	Longitude of startup location in decimal degrees	Eight decimal places supported
	304.16	Heading (true) of an aeroplane when positioned at startup location	Two decimal places recommended
	112	Row code for a node. First node must follow an appropriate header row	111 thru 116
	A6 Run Up	Name of startup location (list will be displayed in X-Plane for each airport)	Short descriptive text string – ten characters or less
18	Light beacon	Maximum of <u>one</u> beacon for each airport	
	18	Row code for an airport light beacon	18
	47.52920400	Latitude of beacon in decimal degrees	Eight decimal places supported
	-122.30412800	Longitude of beacon in decimal degrees	Eight decimal places supported
	1	Code for type of light beacon. Determines colors of beacon.	Integer Beacon Type Code
	BCN	Name of viewpoint (not used by X-Plane)	Descriptive text string (optional)

Row	Meaning <i>Example value</i>	Comment <i>Explanation</i>	<i>Valid values</i>
19	Windsock	Multiple windsocks permitted for each airport	
	19	Row code for a windsock	19
	47.53900921	Latitude of windsock in decimal degrees	Eight decimal places supported
	-122.30868700	Longitude of windsock in decimal degrees	Eight decimal places supported
	1	Flag for windsock lighting	0=unlit, 1=illuminated
	WS	Name of viewpoint (not used by X-Plane)	Descriptive text string (optional)
20	Signs	Taxiway signs or runway distance-remaining signs	
	20	Row code for a sign	20
	47.54099177	Latitude of sign in decimal degrees	Eight decimal places supported
	-122.31031317	Longitude of sign in decimal degrees	Eight decimal places supported
	235.71	Orientation of sign in true degrees (heading of someone looking at sign's front)	Two decimal places recommended
	0	Reserved for future use. Ignore.	0
	2	Code for sign size	Integer Sign Size Code
	{@L}A1{@R}31R-13L	Text to be rendered on sign front and/or back	Text string formatted by Sign Text Definition (see below)
21	Lighting objects	VASI, PAPI, wig-wags, etc.	
	21	Row code for a lighting object	21
	47.53666659	Latitude of lighting object in decimal degrees	Eight decimal places supported
	-122.30585255	Longitude of lighting object in decimal degrees	Eight decimal places supported
	2	Code for type of lighting object	Integer Lighting Object Code
	150.28	Orientation of lighting object in true degrees (looking toward object)	Two decimal places recommended
	3.30	Visual glideslope angle in degrees	Two decimal places. 0.00 if not required. Default is 3.00
	13L	Associated runway number (required for VASI/PAPI, etc)	One to three characters
	PAPI-2L	Description of lighting object (not used by X-Plane)	Short text string (optional)
50	ATC – Recorded	AWOS, ASOS or ATIS	
51	ATC – Unicom	Unicom (US), CTAF (US), Radio (UK)	
52	ATC – CLD	Clearance Delivery	
53	ATC – GND	Ground	
54	ATC – TWR	Tower	
55	ATC – APP	Approach	
56	ATC - DEP	Departure	
	51	Row code for an ATC COM frequency	50 thru 56
	12775	Frequency in MHz x 100 (eg. use "12322" for 123.225MHz)	Five digit integer, rounded DOWN where necessary
	ATIS	Descriptive name (displayed on X-Plane charts)	Short text string (recommend less than 10 characters)

CODES

Codes used to define airport data:

Codes <i>Code value</i>	Comment <i>Code meaning</i>	<i>Code applicability</i>
Surface Type Code	Surface type of runways or taxiways	
1	Asphalt	
2	Concrete	
3	Turf or grass	
4	Dirt (brown)	
5	Gravel (grey)	
12	Dry lakebed (eg. At KEDW)	Example: KEDW (Edwards AFB)
13	Water runways	Nothing displayed
14	Snow or ice	Poor friction. Runway markings cannot be added.
15	Transparent	Hard surface, but no texture/markings (use in custom scenery)
Runway Marking Code	Markings on runway	
0	No runway markings	Disused runways appear like taxiways
1	Visual markings	
2	Non-precision approach markings	
3	Precision approach markings	
4	UK-style non-precision approach markings	UK uses distinctive touch-down zone markings
5	UK-style precision approach markings	UK uses distinctive touch-down zone markings

Codes	Comment	Code applicability
<i>Code value</i>	<i>Code meaning</i>	
Approach Lighting Code	Approach lighting systems	
0	No approach lighting	
1	ALSF-I <ul style="list-style-type: none"> High intensity Approach Light System with sequenced flashing lights 	
2	ALSF-II <ul style="list-style-type: none"> High intensity Approach Light System with sequenced Flashing lights Red side bar lights (barettes) the last 1000', that align with TDZ lighting. 	
3	Calvert <ul style="list-style-type: none"> British - High intensity 	
4	Calvert ILS Cat II and Cat II <ul style="list-style-type: none"> British - High intensity with red side bar lights (barettes) the last 1000' Barettes align with TDZ lighting 	
5	SSALR <ul style="list-style-type: none"> High intensity, Simplified Short Approach Light System With Runway Alignment Indicator Lights (RAIL) 	
6	SSALF <ul style="list-style-type: none"> High intensity, Simplified Short Approach Light System With sequenced flashing lights 	
7	SALS <ul style="list-style-type: none"> High intensity, Short Approach Light System 	
8	MALSR <ul style="list-style-type: none"> Medium-intensity Approach Light System With Runway Alignment Indicator Lights (RAIL) 	
9	MALSF <ul style="list-style-type: none"> Medium-intensity Approach Light System with sequenced flashing lights 	
10	MALS <ul style="list-style-type: none"> Medium-intensity Approach Light System 	
11	ODALS <ul style="list-style-type: none"> Omni-directional approach light system Flashing lights, not strobes, not sequenced 	
12	RAIL <ul style="list-style-type: none"> Runway Alignment Indicator Lights Sequenced strobes and green threshold lights, with no other approach lights 	

Codes	Comment	
<i>Code value</i>	<i>Code meaning</i>	<i>Code applicability</i>
Line Type Code	Painted lines and light strings	
	<i>Note that for all linear features that involve runway entrance hold lines and associated lights (4, 5, 6, 103 & 104 below), the runway is assumed to be to the LEFT of the string and the taxiway to the RIGHT (looking along string from its first node)</i>	
0	Nothing.	
1	Solid yellow line	Taxiway centre lines
2	Broken yellow line	Miscellaneous boundaries
3	Double solid yellow lines	Taxiway edge lines
4	Two broken yellow lines and two solid yellow lines. Broken line on left of string.	Runway hold positions
5	Broken yellow line with parallel solid yellow line. Broken line on left of string.	Other (non-runway) hold locations
6	Yellow cross-hatched line	ILS hold
7	Solid yellow line with broken yellow line on each side	Taxiway centerlines in runway safety zones
8	Widely separated, broken yellow line	Mark 'lanes' for queuing aeroplanes
9	Widely separated, broken double yellow line	Mark 'lanes' for queuing aeroplanes
51-59	Line types 1-9 above with a black border	Use on concrete surfaces for higher contrast
20	Solid white line	Roadway markings
21	White chequerboard pattern	Roadway markings
22	Broken white line	Roadway centreline
	<i>Note that lights added to the edge boundary of a piece of pavement (or hole) will be placed off the edge of the pavement (about one meter).</i>	
101	Green embedded lights, bidirectional along string axis	Taxiway centrelines
102	Blue lights, omnidirectional	Taxiway edge
103	Closely spaced, embedded amber lights. Unidirectional to right of string	Hold lines
104	Closely spaced, pulsating embedded amber lights. Unidirectional to right of string	Runway hold lines
105	Alternating green and amber embedded lights, bidirectional along string axis	Centrelines in runway safety zones
106	Red lights, omnidirectional	Edge lights in dangerous/critical zones (eg. on bridges)
Beacon Type Code	Airport light beacons	
0	No beacon. Suppresses automatic creation of beacon by X-Plane.	Use a dummy airport lat/lon for the location.
1	White-green flashing	Civilian land airport
2	White-yellow flashing	Seaplane base
3	Green-yellow-white flashing	Heliport
4	White-white-green flashing	Military airport
Sign Size Code	Taxiway sign sizes & types	
1	Small taxiway sign	
2	Medium taxiway sign	
3	Large taxiway sign	
4	Large distance-remaining sign on runway edge	Alternatively, can be auto generated for a runway
5	Small distance-remaining sign on runway edge	Alternatively, can be auto generated for a runway

Codes	Comment	
<i>Code value</i>	<i>Code meaning</i>	<i>Code applicability</i>
Lighting Object Code	Lighting objects	
1	VASI	Location is centre point between the two VASI units
2	PAPI-4L, on left of runway	Left-handed: red indication appears first on <u>right</u> 2 lights
3	PAPI-4R, on right of runway	Right-handed: red indication appears first on <u>left</u> 2 lights
4	Space Shuttle PAPI, 20 degree glidepath	Deprecated. Use normal PAPI.
5	Tri-colour VASI	
6	Runway guard ("wig-wag") lights	Pulsating double amber lights alongside runway entrances

TAXIWAY SIGN TEXT DEFINITION

The text on taxiway signs follows [a specification shared with the FlightGear flight simulator](#).

In summary, the text and images on a taxiways sign are represented in X-Plane by:

- **Instructions** define the style of the text and images on the sign. These are always prefixed with the "@" symbol:
 - Black lettering on a yellow background (direction signs) ("@Y").
 - Yellow lettering on a black background (location signs) ("@L").
 - White lettering on a black background (runway distance-remaining signs) ("@B").
 - White lettering on a red background (runway holding point signs) ("@R").
 - Instructions must be included inside curly braces (eg. "{@Y}")
- **Single-character glyphs** define a series of numbers or characters on the sign. These translate one-to-one to the text on the sign. The only allowable single characters are:
 - The numbers "0" through "9", for all sign styles.
 - The uppercase letters "A" through "Z". Only UPPERCASE characters are allowed! No letters are allowed on distance remaining signs.
 - The following single-character symbols are allowed for runway ("@R") and location ("@Y") signs only:
 - Space (represented by an underscore "_")
 - Large dot (represented by an asterisk "*")
 - Vertical separator (represented by the vertical bar "|") (also referred to as a "frame separator")
 - Period, comma, slash and hyphen (".", ",", "/" and "-")
- **Multi-character glyphs** define symbols:
 - Directional arrows (eg. "^lu" for a left-up arrow, "^rd" for a right-down arrow) are allowed for red ("@R") and yellow ("@Y") signs only.
 - The only allowable arrows are: "^l", "^r", "^u", "^d", "^lu", "^ld", "^ru", "^rd"
 - Note that for diagonal arrows, the left/right must precede the up/down. For example, "^dr" is invalid.

- ILS-critical boundary ("critical"). These do not require a sign style.
- Runway safety zone boundary ("safety"). These do not require a sign style.
- No-entry symbols ("no-entry"). These do not require a sign style.
- Hazard (end of taxiway) ("hazard"). These do not require a sign style.
- Switch sides - flip to the back of the sign and start a new text string for the back ("@@")
- Roman numerals (for ILS categories, such as "CAT III") ("r1", "r2" and "r3") are allowed for red ("@R") and yellow ("@Y") signs only.
- Multi-character glyphs must be included inside curly braces (eg. "{r1}")

There are rules about how these three types of data must be structured on a taxiway sign:

- Instructions and single-character glyphs must be UPPERCASE.
- Multi-character glyphs must be lowercase
- Instructions and multi-character glyphs must be enclosed in curly braces ("{}"), to distinguish them from a set of single-character glyphs.
 - If there are multiple consecutive instructions and/or multi-character glyphs, they can be separated within the same set of curly braces by a comma (eg. "{@Y,^l}")
- Spaces are not allowed. Spaces are represented by the underscore ("_") character.

Examples of sign text:

Sign	Sign type	Text to generate this sign
	Direction sign	{@Y}A{^r}
	Location sign	{@L}T
	Location and direction sign	{@L}A{@Y,^l}E{^r}
	Complex sign	{@Y,^l}E {^lu}F{@L}A{@Y}T{^ru} E{^r}
	Direction sign	{@Y}MIL{^r}
	Direction to runway	{@Y}27*33{^r}
	Direction to multiple runways	{@Y}{^l}5 13{^u}
	Runway hold	{@R}15-33
	Runway crossing	{@R,^ld}5-23{^ru} {^lu}9-27{^rd}

Sign	Sign type	Text to generate this sign
	Runway approach area	{@R}15-APCH
	Location & runway hold	{@L}T{@R}18-36
	Runway safety area boundary	<ul style="list-style-type: none"> {safety} If on back of a runway hold sign (above) would be: {@L}T{@R}18-36{@@}{safety}
	ILS critical zone boundary	{critical}
	Hazard (end of taxiway)	{hazard}
	Distance remaining	<ul style="list-style-type: none"> {@B}3 Distance from opposite end of runway might be on back of sign: {@B}3{@@}7

Common errors in sign text:

These are the most common errors found in airport submissions:

- Using a space instead of an underscore symbol for direction (@Y) and runway (@R) signs (eg. "{@Y}RWY 04{^ru}")
- Using spaces or underscores in location (@L) signs (eg. "{@L}STAND_24"). These are not allowed.
- Forgetting the "@" symbol that prefixes an instruction (eg. "{Y}RWY_04{^ru}")
- Using lower case text for single-character glyphs (eg. "{@Y}Rwy_04{^ru}")
- Invalid diagonal arrows - the left/right must precede the up/down (eg. "{@Y}RWY_04{^ur}")
- Forgetting the "^" symbol that prefixes an arrow (eg. "{@Y,ru}B{@L}B")
- Mismatched curly braces (do not use regular parentheses) (eg. "{@Y}RWY_04(^ru)")

If there are errors in the text on a taxiways sign, then X-Plane will not render the sign. Such errors are identified and logged in the log.txt file in your X-Plane system folder. Look for log entries such as:

```
Syntax error - unknown glyph at B{@L}B
Syntax error - missing closing brace.
(in sign '{@L}B5{@R}NO_ENTRY{@Y}{@@}{@Y,ru}B{@L}B')
```

FURTHER INFORMATION

Resources are available for airport designers on my web site at <http://data.x-plane.com>