Fly! II Subsystem Walkthrough

TRI Flyhawk Pitot-Static System

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Author: Chris Wallace c_wallace@sympatico.ca

Introduction

This document provides a walkthrough of the pitot/static system and related dependent instrument subsystems for the TRI Flyhawk aircraft. It explains how pitot and static ports are defined in the aircraft specification, and how they are used by instruments such as the altimeter, vertical speed indicator and airspeed indicator.

There are many good books and websites that explain how pitot/static systems work; this document assumes a basic understanding of what these ports are and how they operate, as well as a familiarity with the stream object files used in Fly! II aircraft specifications.

.NFO File

The starting point for all aircraft systems is the .NFO (Info) file, in this case we're looking at FLYHAWK.NFO. The <_PSS> tag specifies the name of the Pitot/Static Manager file which has an extension of .PSS. The <_AMP> tag specifies the electrical system manager which uses the .AMP file extension. The .AMP file contains subsystem specifications for instruments such as altimeters, airspeed gauges, etc. that use the pitot/static ports defined in the .PSS file.

```
<_AMP> -- Electrical System & Subsystems --
Flyhawk.amp

<_PSS> -- Pitot-Static System --
Flyhawk.pss
```

.PSS File

The .PSS file contains a single object definition for the Pitot/Static Manager. The purpose of this object is to define all of the pitot and static ports, organize them into independent systems, and define parameters that control the icing characteristics of the ports.

The <iceT> tag defines an icing condition duration, if icing is enabled in the program options then this parameter determines how quickly ice forms on the pitot and static ports.

Following the <iceT> tag are a series of <port> tags, one for each pitot or static port on the aircraft. Typically, a small general aviation aircraft will have one or two pitot ports, and two static ports.

Within each port object, the <type> tag specifies what type of port it is, either PITOT or STATIC. The <bPos> tag specifies the location of the port in feet from the aircraft aerodynamic center. The three values x, y, and z represent the lateral, longitudinal and vertical distances respectively.

The <grup> tag specifies a "group" number for the port. All ports must belong to exactly one group; there may be multiple groups if the aircraft has more than one completely independent pitot/static system. There is only one system in the TRI Flyhawk, so all ports have a <grup> value of 1.

In addition to the group number which is assigned through the <grup> tag, each port is also assigned a unique port number based on the order in which the ports are listed in the .PSS file. In the example below, the PITOT port would be automatically assigned a port number of 1, the first (primary) STATIC port would be number 2, and the alternate STATIC port would be number 3. These group and port numbers are required by subsystems in the .AMP file which need to be "connected" to pitot/static sources. This will become apparent in the .AMP file examples below.

The optional <face> tag specifies which side of the aircraft the port exists on, either LEFT or RIGHT. I'm unsure what the significance of this is.

The <inie> tag should be included if the port is an interior port, as would typically be the case for the alternate static port. I'm unsure what the significance of this tag is; perhaps it makes the port immune from any ice accumulation?

Finally, the <stat> tag can be used to override the default state of the port. Normally, there is a default value of 1 for this tag, meaning that all ports are enabled by default. However an alternate static port should have its default state set to disabled until it is enabled by the user activating the alternate air port on the panel.

```
<bgno> -- Begin File --

	///////////////////////////////////////////////////
	//
	//	Pitot Static Systems
	//
	///////////////////////////////////////////////////

	<iceT> -- Icing Condition Duration (sec) --
	60
	<port> -- Port Data --
	<bgno>
		<type> -- Port Type --
		PITOT
		<bPos> -- Port Location --
		-4,1,1
		<grup> -- Group Number --
		1
	<endo>
	<port> -- Port Data --
	<bgno>
```

```
        <type> -- Port Type --
        STATIC
        <bPos> -- Port Location --
        -2,0,0
        <face> -- Fuselage Side --
        LEFT
        <grup> -- Group Number --
        1
<endo>
<port> -- Port Data --
<bgno> -- Alternate Static Port --
        <type> -- Port Type --
        STATIC
        <bPos> -- Port Location --
        0,0,0
        <grup> -- Group Number --
        1
        <inie> -- Interior Port --
        <stat> -- Port Enabled? (1=Yes|0=No) --
        0
<endo>

<endo> -- End of file --
```

.AMP File

The altimeter gauge measures barometric altitude based on the static port pressure. The ‘ALTI’ Altimeter subsystem for Fly! II is connected to the pitot/static system using the <gNum> tag. This specifies the group number of the pitot/static system from which the altimeter gets the static port pressure.

```
<subs> - Subsystem entry -
ALTI
<bgno> - altimeter -
        <unId>
        alti
        <gNum> -- Port Group Number --
        1
<endo>
```

The vertical speed indicator gauge measures the rate of barometric altitude change by monitoring the static port pressure similarly to the altimeter described above. It is connected to a pitot/static system using the <gNum> tag.

```
<subs> - Subsystem entry -
VSI_
<bgno> - vertical speed -
        <unId>
        vsi_
        <gNum> -- Port Group Number --
        1
        <timK>
        0.5
<endo>
```

The airspeed indicator gauge operates by displaying the difference between the dynamic ram air pressure in the pitot port and the atmospheric pressure in the static port. This pressure difference is proportional to the aircraft’s airspeed, and a properly calibrated gauge uses this fact to display the aircraft indicated airspeed (IAS) typically in knots or kph. The <gNum> tag indicates the group number of the pitot/static system that the airspeed indicator is connected to.

```
<subs> - Subsystem entry -
SPED
<bgno> - airspeed -
       <unId>
       sped
       <gNum> -- Port Group Number --
       1
<endo>
```

The ‘phsw’ Pitot Heat Switch subsystem implements a pitot heating functionality that can prevent and/or eliminate icing of the pitot port. When ice forms on the pitot port, erroneous airspeed indications will be seen since the dynamic ram air pressure in the pitot tube will be partially or fully obstructed by ice accumulation. The <aray> tag specifies a list of ports that this heater is connected to. The syntax is:

```
<aray>
INT  (Number of ports in the array)
INT  (First port number)
INT  (Second port number)
...
```

In the TRI Flyhawk there is only a single pitot port, so the array in the example below contains only one value specifying port number 1.

If the aircraft has multiple pitot ports, then the aircraft designer can either must implement multiple ‘phsw’ subsystems, each connected to the appropriate pitot port, or implement a single pitot heater that connects to all pitot ports. The decision would depend on the real-life behaviour of the aircraft, and how much complexity the aircraft designer wanted to put into the electrical system modelling.

```
<subs>
phsw
<bgno> - Pitot Heat Switch -
       <aray> - Port Number Array -
       1
       1
       <fuse> - Pitot Heat Fuse --
       ptht
       <load> - circuit load (amps)
       7.10
<endo>
```

The ‘sssw’ Static Source Switch subsystem provides functionality to enable the activate the alternate static port in case of icing or other blockage of the primary static port. A blockage of the static port will cause erroneous altitude, vertical speed and airspeed indications since the pressure in the static port tube will not accurately reflect the atmospheric pressure. The <aray> tag specifies a list of ports to which the switch is connected in the same way as in the ‘phsw’ subsystem above; in this example there is only one alternate static port so the array contains a single value, port number 3. When the ‘sssw’ subsystem is Active, then it activates the alternate static port; when Inactive, the alternate static port is inactive and only the primary static port is used.

```
<subs>
sssw
```

```
<bgno> - Alternate Static Source Switch -
       <aray> - Port Number Array -
       1
       3
<endo>
```

Conclusion

The TRI Flyhawk uses a very simple pitot/static configuration. There is only a single system (a.k.a. group), which has a single pitot port and two (one primary and one alternate) static ports. More advanced aircraft such as the TRI Peregrine 800TR jet use multiple independent pitot/static systems, and have more complex primary and backup indicator gauges plus EFIS avionics that all connect in to the pitot/static systems. However the basic architecture of the subsystems in the .PSS and .AMP files are pretty much the same, and once the basics are understood then it becomes possible for the aircraft designer to implement almost any configuration imaginable.