ARINC 424 NDB

Draft 1 of Supplement 24
Proposal

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ADD AIRCRAFT TYPE TO ALTITUDES AND SPEEDS

V.0

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SUMMARY
Garmin is proposing an XML-only proposal to add the aircraft type fields (turboprop, jet, etc.) to altitudes and speeds.

1.0 INTRODUCTION/ BACKGROUND

There are many procedures sourced with different procedure leg altitudes and speeds based on the aircraft type. A good example of this is the KSEA CHINS FOUR ARRIVAL (see example below). The RADDY INT has different speeds and altitudes for turbojet versus prop/turboprop and even has different values based on whether you are landing north versus south. The HUMPP INT and AUBRN INT fixes also have speeds and altitudes that only apply to turbojet aircraft landing south.

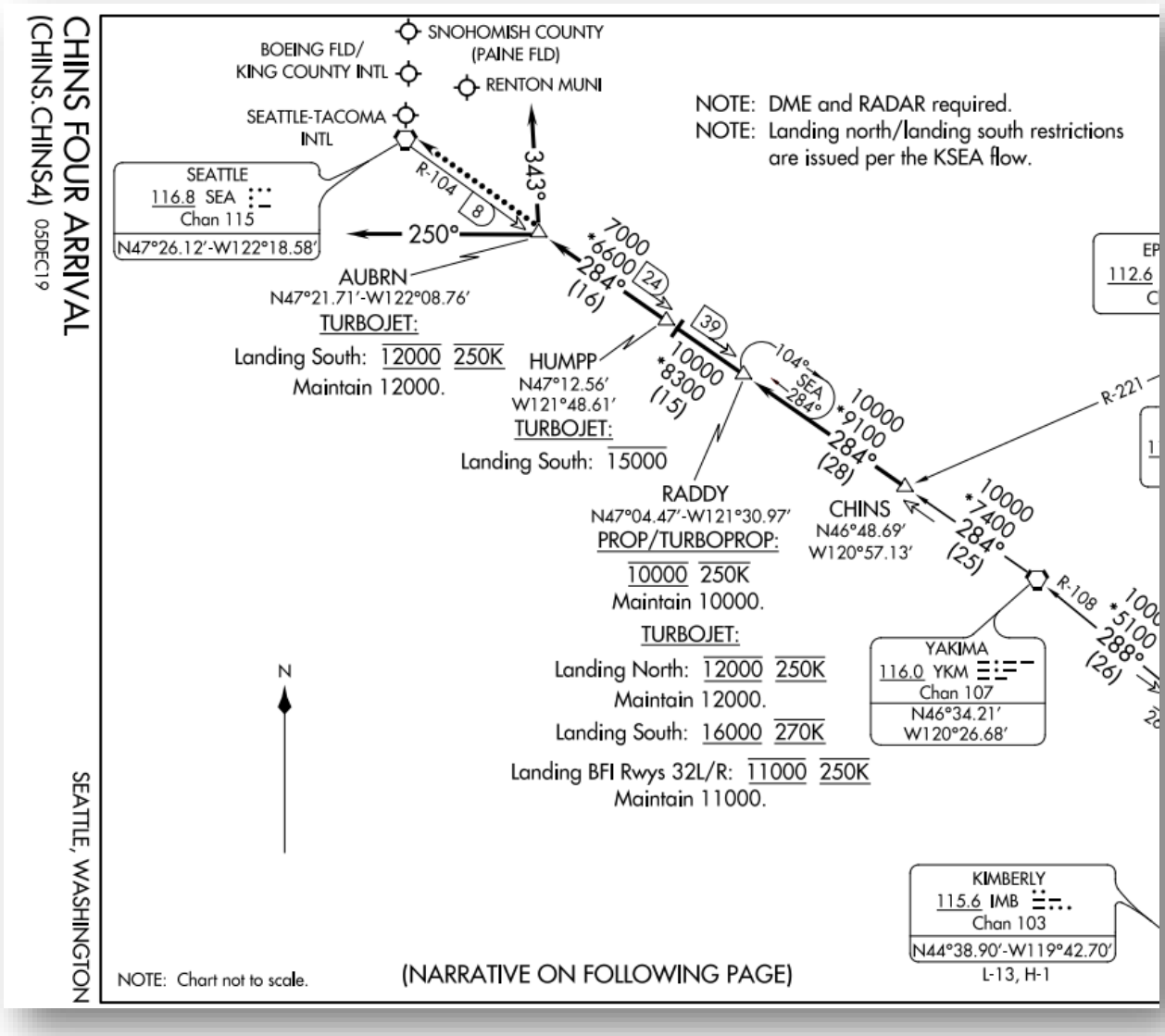

Figure 1: KSEA CHINS4 Example

Another good example is the KMDW MOTIF SIX ARRIVAL (see example below).

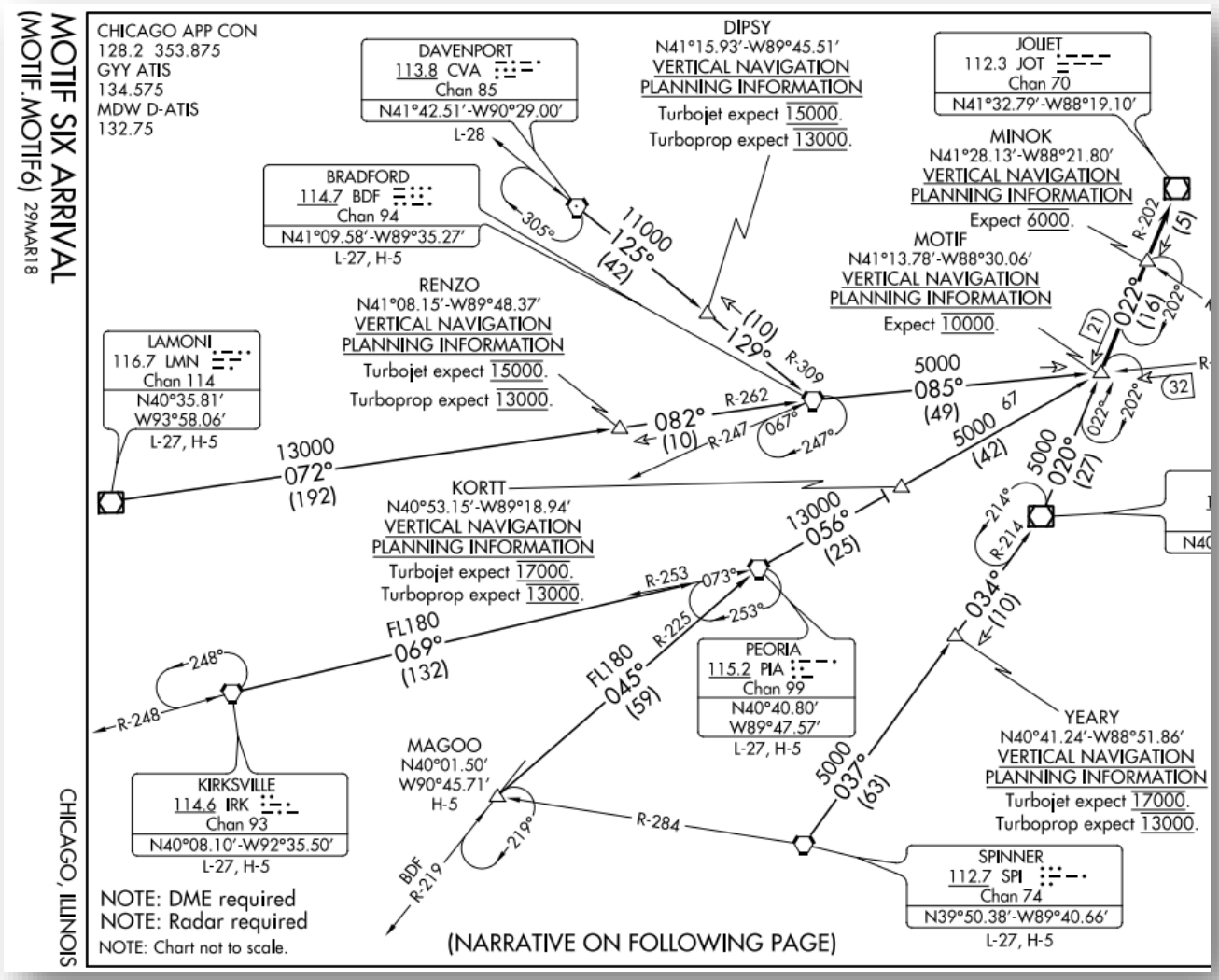

Figure 2: KMDW MOTIF6 Example

The legacy ARINC 424-23 specification does have the Procedure Design Aircraft Category or Type (5.301) field, but it currently only applies to the procedure or procedure transition.

5.301 Procedure Design Aircraft Category or Type

Definition/Description: This field provides the aircraft category(s) or types for which the procedure or portion of a procedure (transition) was designed. This can be aircraft category information or aircraft type information. This field also provides the aircraft category(s) or types applicable to a speed limit in a Controlled Airspace.

Source/Content: The content of this field is derived from official government source and will contain a single alpha character from the table below. For Approach Procedures, the content is specific to a Transition and can vary between Transitions for a single procedure.

AIRCRAFT CATEGORY or TYPE	FIELD CONTENT
Aircraft Category A only	A
Aircraft Category B only	B
Aircraft Category C only	C
Aircraft Category D only	D
Aircraft Category E only	E
Aircraft Categories A and B only	F
Aircraft Categories C and D only	G

AIRCRAFT CATEGORY or TYPE	FIELD CONTENT
Aircraft Categories A, B, and C only	I
Aircraft Categories A, B, C, and D only	J
Aircraft Categories A, B, C, D, E only	K
Aircraft Categories D and E only	L
Aircraft Category H – (Helicopter) only	H
Aircraft Categories B and C only	M
Aircraft Categories C, D, and E only	N
Aircraft Categories B, C, D, and E only	O
Aircraft Type Jets only	W
Aircraft Type Non-Jets only	X
Aircraft Type Pistons only	Y
Aircraft Type Not Limited	P
Aircraft Type Turbojet and Turboprop only	Q
Aircraft Type Turbojet only	R
Aircraft Type Turboprop only	S
Aircraft Type Prop only	T
Aircraft Type Turboprop and Prop	U
Aircraft Type Non-Turbojets only	V
Aircraft Category/Type not provided	Blank

Used On: Airport and Heliport SID, STAR and Approach, and Controlled Airspace Records
Length: 1 Character
Character Type: Alpha (may be blank)

Figure 3: 424-23 Legacy Procedure Design Aircraft Category or Type

This is also applied only to the procedure and procedure transition in the XML:

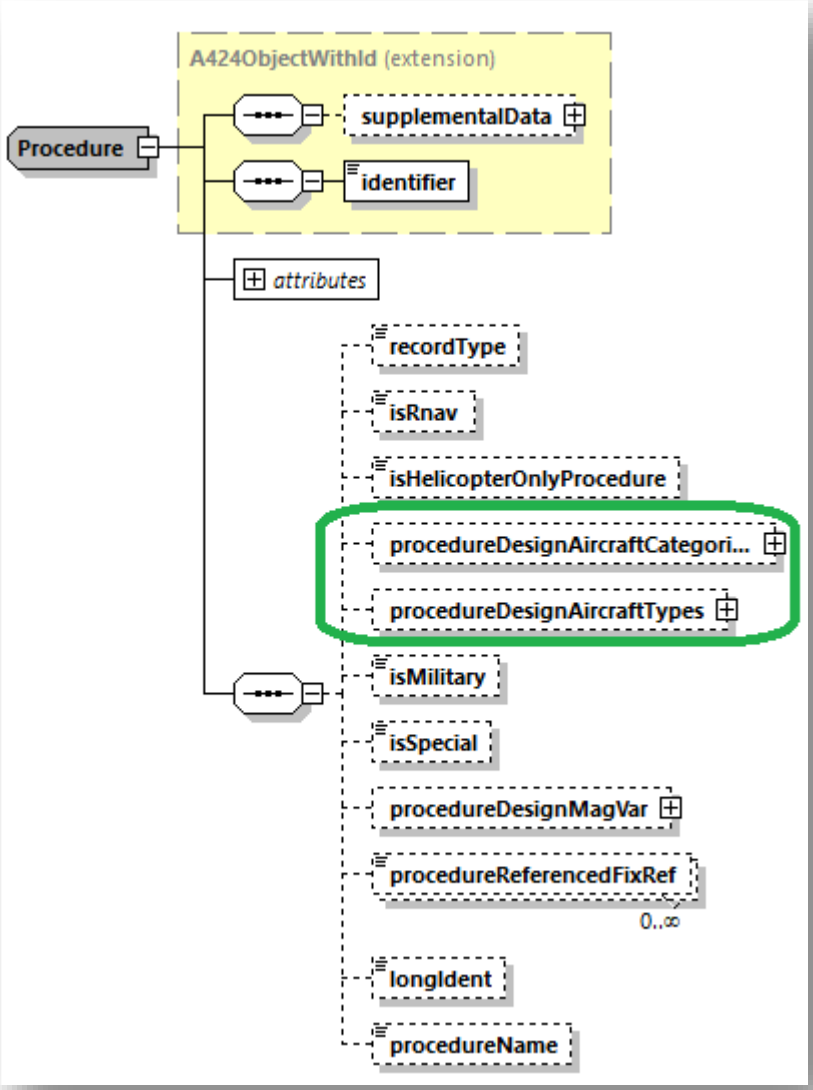

Figure 4: 424-23 XML Procedure

```
<xs:element name="procedureDesignAircraftCategories" type="type:ProcedureDesignAircraftCategories" minOccurs="0" maxOccurs="1">
    <xs:annotation>
        <xs:documentation>This element indicates the category of aircraft that this procedure was designed to support.</xs:documentation>
    </xs:annotation>
</xs:element>
<xs:element name="procedureDesignAircraftTypes" type="type:ProcedureDesignAircraftTypes" minOccurs="0" maxOccurs="1">
    <xs:annotation>
        <xs:documentation>This element indicates the type of aircraft that this procedure was designed to support.</xs:documentation>
    </xs:annotation>
</xs:element>
```

Figure 5: 424-23 XML Procedure Fields

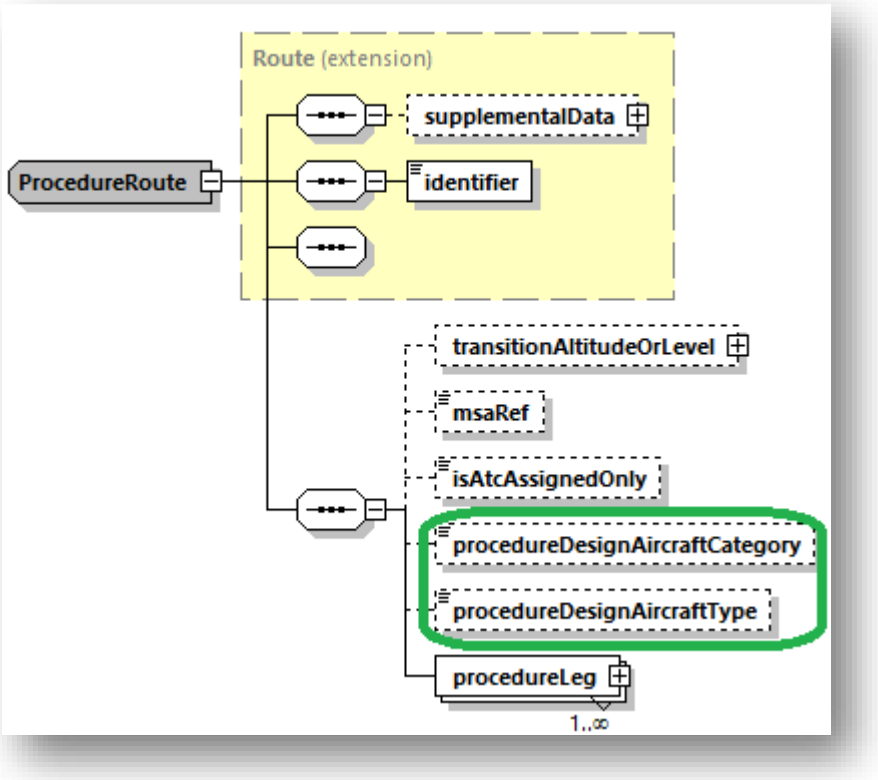

Figure 6: 424-23 XML ProcedureRoute

```
<xs:element name="procedureDesignAircraftCategory" type="enum:ProcedureCategory" minOccurs="0" maxOccurs="1"/>
<xs:element name="procedureDesignAircraftType" type="enum:ProcedureType" minOccurs="0" maxOccurs="1"/>
```

Figure 7: 424-23 XML ProcedureRoute Fields

While looking into the XML, I found that the ProcedureRoute fields are pointing to the wrong fields! They should be “type:ProcedureDesignAircraftCategories” instead of "enum:ProcedureCategory" and “type:ProcedureDesignAircraftTypes” instead of “enum:ProcedureType”. Therefore, the two ProcedureRoute aircraft type/category fields should not be used in the 424-23 XML. I will fix it in 424-24 with this proposal.

Even without those Bugs in the 424-23 XML, the best we could do now is code one altitude and speed per leg. It is my understanding that our NavDB suppliers send us the jet speeds/altitudes when there is conflict between aircraft types. Using the KSEA CHINS4 example, I would expect to receive the Jet values of AT 270 KTS and AT/ABOVE 16000 at the RADDY INT. See my expected example XML below in the 424-23 format.

```
<terminalProcedures>
    <star referenceId="PA_KSEA_PE_CHINS4">
        <identifier>CHINS4</identifier>
        <starRunwayTransition>
            <identifier>RW16B</identifier>
            <!--
            <procedureDesignAircraftType>
                <isTypeTurbojet>true</isTypeTurbojet>
            </procedureDesignAircraftType>
            -->
            <procedureLeg xsi:type="StarLeg">
                <cycleDate>2209</cycleDate>
                <recordType>Standard</recordType>
                <sequenceNumber>010</sequenceNumber>
                <fixRef>EA_CHINS</fixRef>
                <pathAndTermination>IF</pathAndTermination>
            </procedureLeg>
            <procedureLeg xsi:type="StarLeg">
                <cycleDate>2209</cycleDate>
                <recordType>Standard</recordType>
                <sequenceNumber>010</sequenceNumber>
                <fixRef>EA_RADDY</fixRef>
                <pathAndTermination>TF</pathAndTermination>
                <speedLimit>
                    <at>270</at>
                </speedLimit>
                <altitudeConstraint>
                    <atOrAbove>
                        <altitude>16000</altitude>
                    </atOrAbove>
                </altitudeConstraint>
            </procedureLeg>
```

Figure 8: Example KSEA CHINS4 424-23

While the single altitude and speed for a procedure leg works for Garmin's jet customers, it does not allow us to give our smaller aircraft the altitudes and speeds they need for proper flight planning and navigation on these procedures.

2.0 DISCUSSION and/or ACTION

Garmin proposes an XML only proposal to allow more than one altitude and speed per procedure leg. We also propose to add the aircraft type(s) to these values to allow us to distinguish between the cases where we get more than one altitude/speed.

3.0 Legacy ARINC 424 changes as depicted (Track Changes is Helpful)

N/A – XML only proposal

4.0 XML ARINC 424 changes as depicted (Track Changes is Helpful)

- Jira Ticket: ARINC-290
- Git Feature Branch: feature/ARINC-290-add-aircraft-type-to-altitudes-speeds
- Summary of changes:

4.1 Update Legs.xsd, ProcedureLeg:

4.1.1 Change SpeedLimt's maxOccurs to unbounded to allow more than one speed

```
</xs:element>
<xs:element name="speedLimit" type="type:SpeedLimit" minOccurs="0" maxOccurs="1">
<xs:element name="speedLimit" type="type:SpeedLimit" minOccurs="0" maxOccurs="unbounded">
    <xs:annotation>
        <xs:documentation>The "Speed Limit" field defines a speed, expressed in Knots, Ind
    </xs:annotation>
</xs:element>
```

Figure 9: XML Change to Leg speedLimit

4.1.2 Change altitudeConstraint's maxOccurs to unbounded to allow more than one altitude

```
<xs:element name="centerFixRef" type="type:PointReference" minOccurs="0" maxOccurs="1"/>
<xs:element name="altitudeConstraint" type="type:AltitudeConstraint" minOccurs="0" maxOccurs="1"/>
<xs:element name="altitudeConstraint" type="type:AltitudeConstraint" minOccurs="0" maxOccurs="unbounded"/>
<xs:element name="altitudeTermination" type="type:AltitudeTermination" minOccurs="0" maxOccurs="1"/>
```

Figure 10: XML Change to Leg altitudeConstraint

4.2 Update SIDSTARApproach.xsd, Procedure:

4.2.1 Update documentation for procedureDesignAircraftCategories and procedureDesignAircraftTypes to better match the ARINC 424 definition

```
<xs:element name="procedureDesignAircraftCategories" type="type:ProcedureDesignAircraftCategories" minOccurs="0" maxOccurs="1">
    <xs:annotation>
        <xs:documentation>This element indicates the category of aircraft that this procedure was designed to support.</xs:documentation>
        <xs:documentation>Indicates the aircraft category(s) for which the procedure was designed.</xs:documentation>
    </xs:annotation>
</xs:element>
<xs:element name="procedureDesignAircraftTypes" type="type:ProcedureDesignAircraftTypes" minOccurs="0" maxOccurs="1">
<xs:element name="procedureDesignAircraftTypes" type="type:AircraftTypes" minOccurs="0" maxOccurs="1">
    <xs:annotation>
        <xs:documentation>This element indicates the type of aircraft that this procedure was designed to support.</xs:documentation>
        <xs:documentation>Indicates the aircraft type(s) for which the procedure was designed.</xs:documentation>
    </xs:annotation>
</xs:element>
```

Figure 11: XML Change to Procedure documentation

4.3 Update SIDSTARApproach.xsd, Procedure:

4.3.1 Fix the Bugs of the wrong field names and add documentation to clarify these are the transition aircraft categories and types

```
<xs:element name="procedureDesignAircraftCategory" type="enum:ProcedureCategory" minOccurs="0" maxOccurs="1"/>
<xs:element name="procedureDesignAircraftType" type="enum:ProcedureType" minOccurs="0" maxOccurs="1"/>
<xs:element name="procedureDesignAircraftCategory" type="type:ProcedureDesignAircraftCategories" minOccurs="0" maxOccurs="1">
    <xs:annotation>
        <xs:documentation>Indicates the aircraft category(s) for which the portion of a procedure (transition) was designed.</xs:documentation>
    </xs:annotation>
</xs:element>
<xs:element name="procedureDesignAircraftType" type="type:AircraftTypes" minOccurs="0" maxOccurs="1">
    <xs:annotation>
        <xs:documentation>Indicates the aircraft type(s) for which the portion of a procedure (transition) was designed.</xs:documentation>
    </xs:annotation>
</xs:element>
```

Figure 12: XML Change to Transition Aircraft Category & Type

4.4 Update DataTypes.xsd:

4.4.1 Update AltitudeConstraint: Add new aircraftTypes

```
<xs:complexType name="AltitudeConstraint">
    <xs:annotation>
        <xs:documentation>The altitude constraint provides an at, at or above, at or below, or between altitude for a paren
    </xs:annotation>
    <xs:sequence>
        <xs:element name="at" type="type:Constraint" minOccurs="0"/>
        <xs:element name="atOrAbove" type="type:Constraint" minOccurs="0"/>
        <xs:element name="atOrBelow" type="type:Constraint" minOccurs="0"/>
        <xs:element name="aircraftTypes" type="type:AircraftTypes" minOccurs="0">
            <xs:annotation>
                <xs:documentation>Indicates the aircraft type(s) for which the altitude was designed.</xs:documentation>
            </xs:annotation>
        </xs:element>
    </xs:sequence>
</xs:complexType>
```

Figure 13: XML Change to AltitudeConstraint

4.4.2 Update SpeedLimit: Add new aircraftTypes

```
<xs:complexType name="SpeedLimit">
    <xs:annotation>
        <xs:documentation>The Speed Limit field defines a speed, expressed in Knots, Indicated (K.I.A.S.), for a fix in a te
    </xs:annotation>
    <xs:sequence>
        <xs:element name="at" type="type:SpeedValue" minOccurs="0"/>
        <xs:element name="atOrAbove" type="type:SpeedValue" minOccurs="0"/>
        <xs:element name="atOrBelow" type="type:SpeedValue" minOccurs="0"/>
        <xs:element name="aircraftTypes" type="type:AircraftTypes" minOccurs="0">
            <xs:annotation>
                <xs:documentation>Indicates the aircraft type(s) for which the speed limit was designed.</xs:documentation>
            </xs:annotation>
        </xs:element>
    </xs:sequence>
</xs:complexType>
```

Figure 14: XML Change to SpeedLimit

4.4.3 Update ProcedureDesignAircraftTypes:

4.4.3.1 Rename to AircraftTypes

4.4.3.2 Rename all the elements to remove the “Type”

4.4.3.3 Update the documentation to better to define the aircraft type and remove the “only” clause since you can have more than one aircraft type boolean.

```
1974 1984     </xs:complexType>
1975      -   <xs:complexType name="ProcedureDesignAircraftTypes">
     1985 +   <xs:complexType name="AircraftTypes">
1976 1986         <xs:annotation>
1977      -           <xs:documentation>This type provides the aircraft type(s) for which the procedure or portion of a procedure (transition) was designed.
1978      -           </xs:documentation>
     1987 +           <xs:documentation>Indicates the aircraft type(s) for which the data was designed.</xs:documentation>
1979 1988         </xs:annotation>
1980 1989         <xs:sequence>
1981      -           <xs:element name="isTypeJet" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
     1990 +           <xs:element name="isJet" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
1982 1991                <xs:annotation>
1983      -                 <xs:documentation>Aircraft Type Jets only</xs:documentation>
     1992 +                 <xs:documentation>Designed for Jet aircraft</xs:documentation>
1984 1993                </xs:annotation>
1985 1994            </xs:element>
1986      -           <xs:element name="isTypeTurbojet" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
     1995 +           <xs:element name="isTurbojet" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
1987 1996                <xs:annotation>
1988      -                 <xs:documentation>Aircraft Type Turbojet only</xs:documentation>
     1997 +                 <xs:documentation>Designed for Turbojet aircraft</xs:documentation>
1989 1998                </xs:annotation>
1990 1999            </xs:element>
1991      -           <xs:element name="isTypeTurboprop" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
     2000 +           <xs:element name="isTurboprop" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
1992 2001                <xs:annotation>
1993      -                 <xs:documentation>Aircraft Type Turboprop only</xs:documentation>
     2002 +                 <xs:documentation>Designed for Turboprop aircraft</xs:documentation>
1994 2003                </xs:annotation>
1995 2004            </xs:element>
1996      -           <xs:element name="isTypeProp" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
     2005 +           <xs:element name="isProp" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
1997 2006                <xs:annotation>
1998      -                 <xs:documentation>Aircraft Type Prop only</xs:documentation>
     2007 +                 <xs:documentation>Designed for Prop aircraft</xs:documentation>
1999 2008                </xs:annotation>
2000 2009            </xs:element>
```

Figure 15: XML Change to ProcedureDesignAircraftTypes Part 1

```
2001      -             <xs:element name="isTypePiston" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
      2010 +            <xs:element name="isPiston" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
2002  2011                <xs:annotation>
2003      -                 <xs:documentation>Aircraft Type Pistons only</xs:documentation>
      2012 +                <xs:documentation>Designed for Piston aircraft</xs:documentation>
2004  2013                </xs:annotation>
2005  2014              </xs:element>
2006      -             <xs:element name="isTypeNonJets" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
      2015 +            <xs:element name="isNonJet" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
2007  2016                <xs:annotation>
2008      -                 <xs:documentation>Aircraft Type Non-Jets only</xs:documentation>
      2017 +                <xs:documentation>Designed for Non-Jet aircraft</xs:documentation>
2009  2018                </xs:annotation>
2010  2019              </xs:element>
2011      -             <xs:element name="isTypeNotLimited" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
      2020 +            <xs:element name="isNonTurbojets" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
2012  2021                <xs:annotation>
2013      -                 <xs:documentation>Aircraft Type Not Limited</xs:documentation>
      2022 +                <xs:documentation>Designed for Non-Turbojets aircraft</xs:documentation>
2014  2023                </xs:annotation>
2015  2024              </xs:element>
2016      -             <xs:element name="isTypeNonTurbojets" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
      2025 +            <xs:element name="isTypeNotLimited" type="xs:boolean" minOccurs="0" maxOccurs="1" default="false">
2017  2026                <xs:annotation>
2018      -                 <xs:documentation>Aircraft Type Non-Turbojets only</xs:documentation>
      2027 +                <xs:documentation>Designed for aircraft type is not limited</xs:documentation>
2019  2028                </xs:annotation>
2020  2029              </xs:element>
2021  2030            </xs:sequence>
2022  2031          </xs:complexType>
```

Figure 16: XML Change to ProcedureDesignAircraftTypes Part 2

5.0 Examples

Looking at the current example KSEA CHINS4 using the current 424-23 XML versus the proposed 424-24 XML shows how the aircraft type fields, and multiple altitudes/speeds per procedure leg, helps provide the Jet aircraft altitudes & speeds from the Prop/Turboprop altitudes & speeds.

Full XML:

Example_KSEA_star_CHINS4_Current.xml

Example_KSEA_star_CHINS4_Proposed.xml

See the last page for screenshots of the differences.

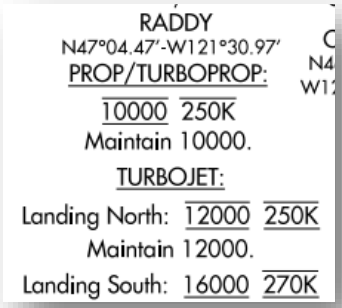

Figure 17: Example KSEA CHINS4 Source

```
<terminalProcedures>
    <star referenceId="PA_KSEA_PE_CHINS4">
        <identifier>CHINS4</identifier>
        <starRunwayTransition>
            <identifier>RW16B</identifier>
            <!--
            <procedureDesignAircraftType>
                <isTypeTurbojet>true</isTypeTurbojet>
            </procedureDesignAircraftType>
            -->
            <procedureLeg xsi:type="StarLeg">
                <cycleDate>2209</cycleDate>
                <recordType>Standard</recordType>
                <sequenceNumber>010</sequenceNumber>
                <fixRef>EA_CHINS</fixRef>
                <pathAndTermination>IF</pathAndTermination>
            </procedureLeg>
            <procedureLeg xsi:type="StarLeg">
                <cycleDate>2209</cycleDate>
                <recordType>Standard</recordType>
                <sequenceNumber>010</sequenceNumber>
                <fixRef>EA_RADDY</fixRef>
                <pathAndTermination>TF</pathAndTermination>
                <speedLimit>
                    <at>270</at>
                </speedLimit>
                <altitudeConstraint>
                    <atOrAbove>
                        <altitude>16000</altitude>
                    </atOrAbove>
                </altitudeConstraint>
            </procedureLeg>
```

Figure 18: Example KSEA CHINS4 424-23 Current

```
<terminalProcedures>
    <star referenceId="PA_KSEA_PE_CHINS4">
        <identifier>CHINS4</identifier>
        <starRunwayTransition>
            <identifier>RW16B</identifier>
            <procedureLeg xsi:type="StarLeg">
                <cycleDate>2209</cycleDate>
                <recordType>Standard</recordType>
                <sequenceNumber>010</sequenceNumber>
                <fixRef>EA_CHINS</fixRef>
                <pathAndTermination>IF</pathAndTermination>
            </procedureLeg>
            <procedureLeg xsi:type="StarLeg">
                <cycleDate>2209</cycleDate>
                <recordType>Standard</recordType>
                <sequenceNumber>020</sequenceNumber>
                <fixRef>EA_RADDY</fixRef>
                <pathAndTermination>TF</pathAndTermination>
                <speedLimit>
                    <at>270</at>
                    <aircraftTypes>
                        <isTurbojet>true</isTurbojet>
                    </aircraftTypes>
                </speedLimit>
                <speedLimit>
                    <atOrBelow>250</atOrBelow>
                    <aircraftTypes>
                        <isTurboprop>true</isTurboprop>
                        <isProp>true</isProp>
                    </aircraftTypes>
                </speedLimit>
                <altitudeConstraint>
                    <atOrAbove>
                        <altitude>16000</altitude>
                    </atOrAbove>
                    <aircraftTypes>
                        <isTurbojet>true</isTurbojet>
                    </aircraftTypes>
                </altitudeConstraint>
                <altitudeConstraint>
                    <at>
                        <altitude>10000</altitude>
                    </at>
                    <aircraftTypes>
                        <isTurboprop>true</isTurboprop>
                        <isProp>true</isProp>
                    </aircraftTypes>
                </altitudeConstraint>
            </procedureLeg>
```

Figure 19: Example KSEA CHINS4 424-24 Proposed