

Manual No. 193, Volume 3

61-03-93

Revision 3

January 2025



Information Manual for Experimental Aircraft

Volume 3

Application Information for Van's Aircraft

Hartzell Propeller LLC

One Propeller Place

Piqua, Ohio 45356-2634 U.S.A.

Phone: 937.778.4200

Fax: 937.778.4215



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61-03-93

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IMPORTANT MESSAGE

People who build, modify, and/or operate experimental aircraft should recognize that various types of risks are involved; and they should take all precautions to minimize them, since they cannot be eliminated entirely. The propeller is a vital component of the aircraft. A mechanical failure of the propeller could cause a forced landing or create vibrations sufficiently severe to damage the aircraft, possibly causing it to become uncontrollable.

Propellers are subject to constant vibration stresses from the engine and airstream, which are added to high bending and centrifugal stresses.

Before a propeller is certified as being safe to operate on an airplane, an adequate margin of safety must be demonstrated. Even though every precaution is taken in the design and manufacture of a propeller, history has revealed rare instances of failures, particularly of the fatigue type.

It is essential that the propeller is properly maintained according to the recommended service procedures and a close watch is exercised to detect impending problems before they become serious. Any grease or oil leakage, loss of air pressure, unusual vibration, or unusual operation should be investigated and repaired, as it could be a warning that something serious is wrong.

For operators of uncertified or experimental aircraft an even greater level of vigilance is required in the maintenance and inspection of the propeller. Experimental installations often use propeller-engine combinations that have not been tested and approved. In these cases, the stress on the propeller and, therefore, its safety margin is unknown. If a failure occurs, it could be as severe as a loss of propeller or propeller blades and cause loss of propeller control and/or loss of aircraft control.

Hartzell Propeller follows FAA regulations for propeller certification on certificated aircraft. Experimental aircraft may operate with unapproved engines or propellers or engine modifications to increase horsepower/maintain horsepower output with a reduction in fuel flow. These modifications affect the vibration output of the engine and the stress levels on the propeller. Significant propeller life reduction and failure are real possibilities.

Frequent inspections are strongly recommended if operating with a non-certificated installation; however, these inspections may not guarantee propeller reliability, as a failing device may be hidden from the view of the inspector. Propeller overhaul is strongly recommended to accomplish periodic internal inspection.

Inspect the propeller/blades in accordance with the applicable operation/maintenance documents.

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RECORD OF REVISIONS

This is a record of all revisions to this manual.

ATTENTION: Always use the current revision of this manual. The current revision is available on the Hartzell website at www.hartzellprop.com.

Revision Number	Issue Date	Revision Number	Issue Date
Original	Feb/23		
1	Aug/23		
2	May/24		
3	Jan/25		

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1. Introduction and Applicability

A. Introduction

Hartzell Manual 193 consists of multiple Volumes that describe the commonly used propeller configurations and options for experimental aircraft including discussions of installation guidelines, engine/propeller compatibility, and considerations for selecting a Hartzell Propeller for an experimental aircraft. These documents provide a summary/overview, and are not intended to be a replacement for guidance from the aircraft, engine, and/or propeller manufacturers about the appropriate propeller selection. When in doubt, please consult Hartzell Propeller Owner's manuals and/or the appropriate aircraft kit manuals. Additionally, you may contact Hartzell and/or the aircraft designer directly for guidance.

B. Applicability

Guidance in this manual is intended to enhance the safety and efficiency surrounding the use and integration of propellers on experimental aircraft. Government regulations, specifically 14 CFR Parts 23, 33, and 35, may not have regulatory requirements applicable to the aircraft in question. However, the builder/operator/integrator of an experimental aircraft, regardless of whether it is newly built or a modified version of an existing aircraft, should consider the same governmental regulations, policy, and guidance materials when developing and testing their aircraft. These topics regularly address physical concepts that apply regardless of airworthiness category. The ultimate responsibility for determining the proper integration of the propeller and aircraft lies with the aircraft owner/operator.

2. Propeller/Blade Model Designation

A. Model Number Designation System

Hartzell Propeller uses a model number designation system to identify specific propeller and blade assemblies. The propeller model number and blade model number are separated by a slash (/).

Example: *propeller model number / blade model number*
 (e.g. HC-C2YR-1BFPX/F7497X)

Parentheses shown in the propeller/blade model number in this, or any other Hartzell publication, indicate that there are characters (letters or numbers) that, depending on the specific configuration, may or may not be present.

For additional information about the propeller/blade model designation system, refer to the applicable Hartzell propeller owner's manual and/or the applicable Type Certificate Data Sheet (TCDS).

3. WARNINGS and CAUTIONS

WARNING 1: THIS DOCUMENT, IN CONJUNCTION WITH THE PROPELLER OWNER'S MANUAL, PROVIDES IMPORTANT INFORMATION AND WARNINGS REGARDING THE INSTALLATION, OPERATION, AND PERFORMANCE OF YOUR PROPELLER.

WARNING 2: DETERMINING THE PROPER INTEGRATION OF THE PROPELLER AND AIRCRAFT IS THE RESPONSIBILITY OF THE AIRCRAFT INTEGRATOR. HARTZELL PROPELLER SUPPLIES A PROPELLER BASED ON INFORMATION PROVIDED BY THE AIRCRAFT INTEGRATOR THAT HARTZELL CANNOT AND MAY NOT BE ABLE TO VERIFY. NEW PROPELLER APPLICATIONS REQUIRE CAREFUL TESTING AND EVALUATION. TESTING OR OPERATION OF THE PROPELLER, THEREFORE, CARRIES WITH IT A RISK OF SERIOUS INJURY, DEATH, AND/OR SIGNIFICANT PROPERTY DAMAGE.

WARNING 3: THERE IS A RISK OF SERIOUS INJURY, DEATH, AND/OR SIGNIFICANT PROPERTY DAMAGE IF THE PROPELLER HAS NOT BEEN TESTED AND SHOWN TO BE COMPATIBLE WITH THE ENGINE AND AIRCRAFT INSTALLATION, OR IF IT IS OPERATED IN A MANNER THAT EXCEEDS THE ESTABLISHED LIMITS FOR THE PROPELLER. IN THESE INSTANCES, VIBRATION LOADS CAN EXCEED THE DESIGN LIMITATIONS AND CAN RESULT IN PROPELLER OR BLADE SEPARATION FROM THE AIRCRAFT.

WARNING 4: STABILIZED OPERATION WITHIN THE PROPELLER RESTRICTED RPM RANGE CAN GENERATE HIGH PROPELLER STRESSES AND RESULT IN FATIGUE DAMAGE TO THE PROPELLER. THIS DAMAGE CAN LEAD TO A REDUCED PROPELLER FATIGUE LIFE, PROPELLER FAILURE, AND LOSS OF CONTROL OF THE AIRCRAFT.

4. Trademarks and Disclaimers

A. Designers/Kit Manufacturers

This manual mentions various suppliers of aircraft kits, designs, engines, and aftermarket products. The information contained herein is not endorsed, or approved by, any of these entities.

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1. Recommended Hartzell Propellers for Van's Aircraft Models

A. Propeller Options by Aircraft Model/Engine Type

The table below lists the recommended Hartzell propeller(s) based on the Aircraft Model, Engine, and Blade Material. Engine models listed here are not necessarily those approved by Van's Aircraft for use on the RV models listed; please contact Van's for applicable engine information. The engine combinations described here are general engine series, for specific information on vibrational compatibility of specific propeller and engine combinations, refer to Manual 193, Volume 1.

For topics regarding the integration of the propeller onto the airframe, refer to Manual 193, Volume 2. The details in these volumes may influence your propeller selection and configuration.

While these are our recommendations based on the best information we have, your build may have unique requirements and there may be multiple configurations of the "same" propeller available. These configurations are described by variations in the propeller model (refer to the section, "Propeller/Blade Model Designation" in this manual, and Manual 193, Volume 2). When configured for a specific installation, a model is assigned a specific part number; most available configurations and part numbers are listed under "Van's" in Hartzell Manual 159. As the integrator, it's up to you to consider all the factors involved in selecting the configuration for your application.

For detailed information about the recommended propeller, click on the hyperlinked text, or refer to the applicable propeller in the "Propeller Details" section of this chapter.

Recommended Propellers by Aircraft/Engine Model

Aircraft Model(s)	Engine(s)	Blade Material	No. of Blades	Recommended Propeller(s)	Marketing Designation
RV-3 RV-4 RV-6(A) RV-7(A) RV-8(A) RV-9(A)	320	Aluminum	2	HC-C2YL-1BFX / F7663-4X	N/A
		Composite	3	3C1-L430A1X() / 76C(S)03-(2,4,7)X2	Explorer
RV-4* RV-6(A)* RV-7(A) RV-8(A) RV-14(A)	360-390	Aluminum	2	(B)HC-(C,M)2YR-1BFPX / F7497(-2)X	Blended Airfoil
		Composite	2	HC-(C,G,M)2YR-1N(W)X / N7605(W)-(2,4)X	N/A
			2	2C1-R(419,675)A1X/75CS08(-2)X	Carbon Blended Airfoil
			3	3C1-R(430, 675)A1X() / 76C(S)03-(2,4)X2	Explorer
RV-10	540	Aluminum	2	HC-C2YR-1BFPX / F8068DX	Super Scimitar
		Composite	3	HC-(C,G)3Y(1)R-1N(W)X / N7605C(W)X	N/A
			3	3C1-R430A1X() / 76C(S)04X2	Explorer
RV-15	360-390	Composite	2	HC-C2YR-1NX / NG8301-3X1	Trailblazer
			3	3C1-R430A1X() / 80C(S)01()X	Pathfinder

* These models are known to have engine displacement limitations.

2. Van's RV Aircraft Modifications

NOTE: Some modifications to "stock" RV models may affect propeller choices.

A. RV-3 and RV-4 Models

RV-3 and RV-4 models with cowlings before ~1995 use a smaller 12" spinner. This small spinner may or may not fit around Hartzell constant speed propeller hubs; we know that people have used Hartzell propellers on aircraft of this vintage but Hartzell cannot verify the modifications or procedures necessary. Hartzell does not currently have any spinners that size for these aircraft.

B. James Aircraft Cowlings

James Aircraft extended cowlings use an M hub extension for the compact series of propellers, and a 675 extension for the Raptor series. The "shorty" cowlings take the same extension as the stock aircraft, except when using a propeller with N7605() blades.

C. Showplanes Cowlings

Showplanes extended cowling for the RV-8(A) uses an M hub extension for the compact series of propellers; configuration for the Raptor-series has not yet been defined. The Showplanes cowlings use a larger diameter spinner, Hartzell typically supplies a C-3533-1(P) spinner for two blade, compact hub propellers. One builder report indicates that the combination of an HC-G3Y1R-1NX/N7605CX propeller and D-7709(P) spinner worked well with the Showplanes RV-10 cowling; we recommend verifying this will work for your application if you intend to replicate it.

3. Spinner Assemblies

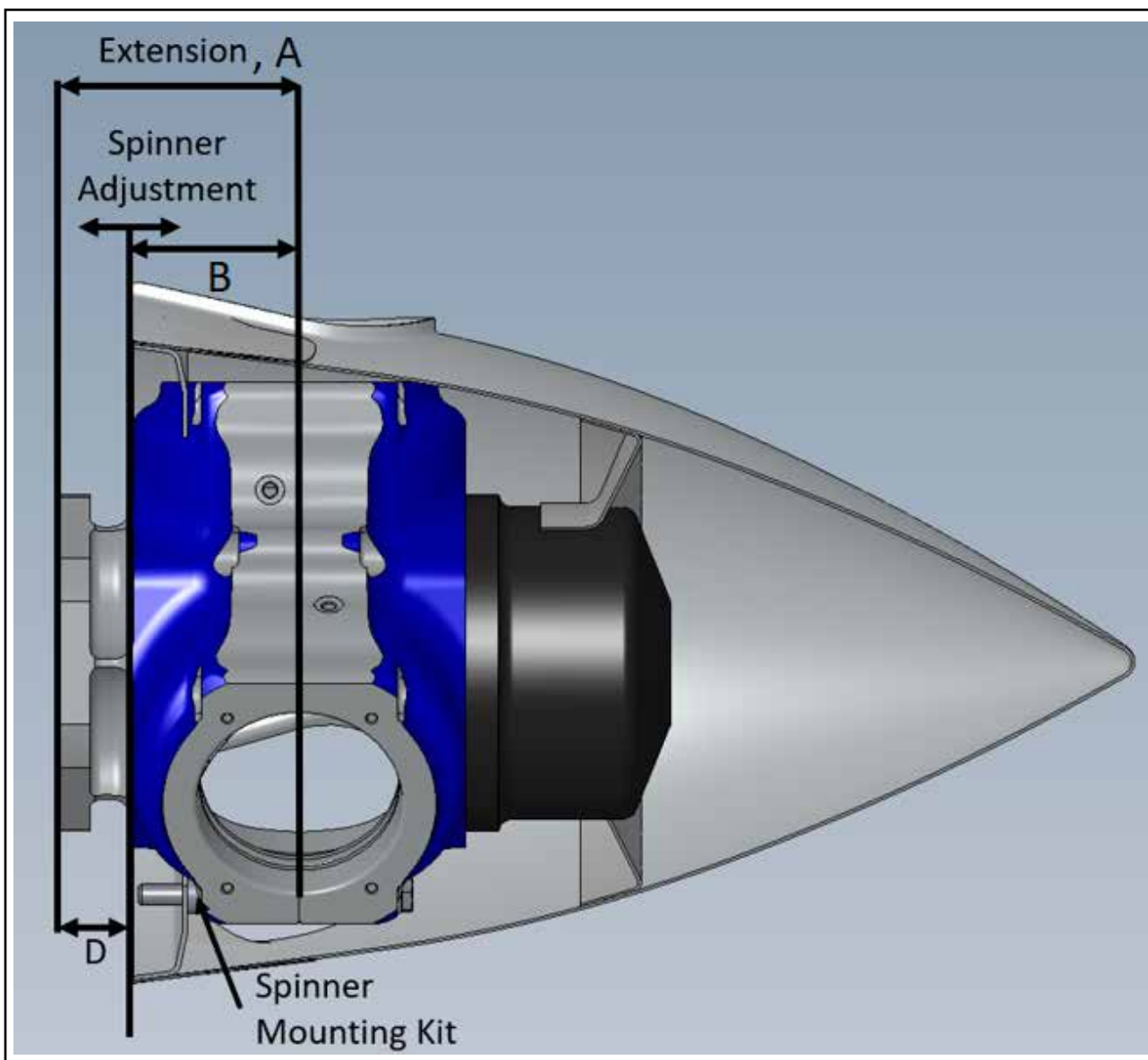
A. Kit Spinners

Hartzell has provided information to Van's for adapting the kit components to Hartzell hubs. The kit component spinner is known to work with two blade compact propellers with metal blades. Minor modifications allow usage with the two blade Raptor propeller. More significant modifications are required for usage with a three blade Raptor propeller.

ATTENTION: Hartzell offers the following spinners for RV models as an alternative to the kit components. Adjustment distances are provided for reference to aid the builder in selecting, where appropriate, the correct spinner and hub extension (refer to Manual 193, Volume 2 for information on hub extensions) combination for their installation. Clearance is not assured, therefore must be measured. Blade design and spinner blade cutout may impact adjustment range; the 7663 blade in particular is limited.

B. Spinner Application Example

Here is an example of how to use the information in this volume and Volume 2 to select an appropriate configuration. Let's say you want to replace your existing propeller with a new 3-blade composite Explorer propeller. You see that there are several spinners listed for the 3-blade Raptor series propeller and aren't sure which to use. Use the steps in this section and Figure 1-1 to determine the appropriate spinner.



Spinner Fit Diagram
Figure 1-1

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- (1) Measure the distance between your engine flange/starter ring gear and cowling, and the diameter of the cowlring, see the figure in the Integration section of Volume 2 for instructions
 - (a) You measure 1.375" between the starter ring gear and the cowling
 - (b) You measure the cowl ring diameter as 13.7"
 - 1 This narrows the spinner choices down to the 107186 and the 107974
- (2) Select an appropriate clearance gap between your cowling and spinner: 0.375", and add this to the measurement:
 - (a) 1.750", we'll call this dimension "D"
- (3) You see that the standard extension for the propeller is the 430 extension. Look up the length of this extension in the propeller configuration section of Volume 2.
 - (a) The 430 extension is 4.287" long, we'll call this dimension "A"
- (4) Subtract Dimension D from Dimension A. This gives the distance aft of centerline that the aft edge of the spinner will sit:
 - (a) 2.537", we'll call this dimension "B"
- (5) Compare this dimension to the adjustment ranges of the spinners
 - (a) In this case, "B" falls within the adjustment range of the 107974 spinner, but not the 107186 spinner.

C. D-4798(P)

An aluminum, optionally polished (P), spinner used with two blade G hub compact propellers and the N7605() blade to generate adequate blade trail edge to cowling clearance. Using this spinner with a C hub during fit up for a new build will result in the cowling moving aft and being trimmed short, as a retrofit or using the plans spinner mockup the spinner would most likely interfere with the cowling.

D-4798(P) Attributes

Attribute	Value
Outside Diameter	~12.7 in.
Length	~17.4 in.
Weight	~4.5 lbf.
Max. Adjustment Aft of Blade Centerline	3.255 in.
Min. Adjustment Aft of Blade Centerline	3.190 in.

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D. C-3533-1(P)

An aluminum, optionally polished (P), spinner used with two blade compact propellers and Showplanes cowlings. The 7663, if used with this spinner, has no adjustment beyond max aft.

C-3533-1(P) Attributes

Attribute	Value
Outside Diameter	~14.8 in.
Length	~20.1 in.
Weight	~5.6 lbf.
Max. Adjustment Aft of Blade Centerline	3.461 in.
Min. Adjustment Aft of Blade Centerline	3.212 in.

E. C-4582(-P)

An aluminum, optionally polished (P), spinner used with three blade compact propellers; typically used for the RV-10.

C-4582(-P) Attributes

Attribute	Value
Outside Diameter	~13.2 in.
Length	~17.4 in.
Weight	~3.9 lbf.
Max. Adjustment Aft of Blade Centerline	3.201 in.
Min. Adjustment Aft of Blade Centerline	2.889 in.

F. 107186(P)

An aluminum, optionally polished (P), spinner for three blade Raptor propellers. This spinner will fit new builds, when the cowling is matched to the spinner, but may not offer enough fore/aft adjustment to be used with retrofit installations; cowling fit should be checked first.

107186(P) Attributes

Attribute	Value
Outside Diameter	~13.2 in.
Length	~17.3 in.
Weight	~4.2 lbf.
Max. Adjustment Aft of Blade Centerline	2.933 in.
Min. Adjustment Aft of Blade Centerline	2.744 in.

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G. 107974(F1,F2)

A hybrid spinner utilizing a composite dome with an aluminum bulkhead for three blade Raptor propellers. Offered in primer (no suffix), Matterhorn White (F1), and Sterling Silver Metallic (F2). Check cowling fit for retrofits.

107974(F1,F2) Attributes

Attribute	Value
Outside Diameter	~13.5 in.
Length	~17.3 in.
Weight	~3.5 lbf.
Max. Adjustment Aft of Blade Centerline	2.630 in.*
	2.836 in.**
Min. Adjustment Aft of Blade Centerline	2.318 in.
* NOTE: With standard spinner mounting kit bolts.	
** NOTE: With alternate spinner mounting kit using longer bolts.	

H. D-7709(P)

An aluminum, optionally polished (P), spinner used with three blade compact propellers; used for the RV-10 with a Showplanes Cowling.

D-7709(P) Attributes

Attribute	Value
Outside Diameter	~14.6 in.
Length	~19.1 in.
Weight	~5.5 lbf.
Max. Adjustment Aft of Blade Centerline	3.618 in.
Min. Adjustment Aft of Blade Centerline	3.369 in.

I. 105905(P)

An aluminum, optionally polished (P), spinner used with three blade Raptor propellers; identified for the RV-10 with a Showplanes Cowling.

105905(P) Attributes

Attribute	Value
Outside Diameter	~14.6 in.
Length	~19.2 in.
Weight	~5.9 lbf.
Max. Adjustment Aft of Blade Centerline	2.508 in.
Min. Adjustment Aft of Blade Centerline	2.259 in.

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J. 109490(P)X

An aluminum, optionally polished (P), spinner used with two blade Raptor or Compact propellers for RVs with stock cowlings. This was designed specifically for RVs to be an aluminum version of the stock Van's kit fiberglass spinner.

109490(P)X Attributes

Attribute		Value
Outside Diameter		~13.0 in.
Length		~16.8 in.
Weight		~4.5 lbf.
Max. Adjustment Aft of Blade Centerline	Blade Model:	
	7497	2.804 in.
	8068	2.889 in.
	75C(S)08	3.063 in.
Min. Adjustment Aft of Blade Centerline	Blade Model:	
	7497	2.434 in.
	8068	2.452 in.
	75C(S)08	2.278 in.

4. Ground Clearance

NOTE: The table below, provides a recommended propeller diameter based on the information available to Hartzell Propeller. Please contact Van's for direct confirmation of the propeller diameter.

Recommended Diameters for Ground Clearance

Aircraft Model	Tricycle	Tailwheel
RV-3	n/a	70 in.*
RV-4 (std. gear)	n/a	70 in.*
RV-4 (long gear)	n/a	72 in.*
RV-6(A)	74 in.	72 in.
RV-7(A)	74 in.	72 in.
RV-8(A)	74 in.	74 in.
RV-9(A)	74 in.	72 in.
RV-10	80 in.	n/a
RV-12	70 in.	n/a
RV-14(A)	74 in.	72 in.
* NOTE: Reduced confidence in value. Contact Van's.		

5. Propeller Details

This section provides details on specific propeller models, as well as typical, general engine series used with those propellers. For specific information on vibrational compatibility of specific propeller and engine combinations, please refer to Manual 193, Volume 1. Please also see Manual 193, Volume 2 for topics regarding the integration of the propeller onto the airframe. The details in these volumes may influence your propeller selection and configuration.

NOTE: Refer to the section, "Recommended Hartzell Propellers for Van's Aircraft Models" for propeller recommendations by aircraft model and engine.

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A. (B)HC-(C,M)2YR-1BFPX/F7497(-2)X

This is a two blade compact propeller with aluminum blades. Widely known as the “Blended Airfoil” prop, or the “BA” prop, this propeller has been, and continues to be, popular on many RV models with 360-390 engines and for good reason. Widely regarded as the fastest prop available, and pretty much the benchmark against which all other RV props are compared due to its wide range of performance and excellent value. This propeller is available in either 74” or 72” diameter and typically configured with a C hub extension. An M hub extension is also available for use with aftermarket extended cowlings. This propeller is also used on other experimental aircraft such as Glasairs, Mustangs, and T-18s, as well as on certified aircraft like the Mooney M20(various), Piper Arrow, and Diamond DA 40. The ()7499() is a life limited version of the ()7497() for applications with more severe engine vibration characteristics.

(B)HC-(C,M)2YR-1BFPX/F7497(-2)X Attributes

Characteristic	Value
Number of Blades	2
Available Diameters	74" / 72"
Typical Extensions	C / M
Weight, C/M hub	58.5 / 63 lbf.
Typical Engine Displacement	360 / 390



(B)HC-(C,M)2YR-1BFPX/F7497(-2)X

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B. HC-(C,G,M)2YR-1N(W)X/N7605(-2,-4)(W)X

This is a two blade compact propeller with composite blades, the first ASC-II composite propeller Hartzell introduced to the recip market and is immediately identifiable by its wide chord design. This propeller loses some top end speed compared to the 7497, but saves considerable weight off the nose of the aircraft. Some pilots prefer this propeller for aerobatics due to the increased drag at idle that the big blades can provide. The wide chord, in combination with the high blade angles needed in cruise for fast aircraft like the RV series can lead to interference issues between the cowling and the blade trailing edge. This issue is most common on the RV-8(A), due to it's unique cowling. The G hub extension moves the blades further away from the engine, and the D-4798(P) spinner aligns the cowling further aft than the kit supplied spinner components for proper blade to cowling clearance. An M hub extension is also available for use with aftermarket extended cowlings.

(B)HC-(C,G,M)2YR-1N(W)X/N7605(-2,-4)(W)X Attributes

Characteristic	Value
Number of Blades	2
Available Diameters	76" / 74" / 72"
Typical Extensions	C / G / M
Weight, C/G/M hub	42 / 43 / 48 lbf.
Typical Engine Displacement	360 / 390



(B)HC-(C,G,M)2YR-1N(W)X/N7605(-2,-4)(W)X

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C. HC-C2YR-1BFPX/F8068DX

The best “Bang for the Buck” prop available for the RV-10, this is a two blade compact propeller with aluminum blades. The same blade design is the blade of choice for Rockets, also known as the Super Scimitar blade. Available in 80” diameter and typically configured with a C hub extension.

HC-C2YR-1BFPX/F8068DX Attributes

Characteristic	Value
Number of Blades	2
Available Diameters	80"
Typical Extensions	C
Weight, C hub	54 lbf.
Typical Engine Displacement	540



HC-C2YR-1BFPX/F8068DX

D. HC-(C,G)3Y(1)R-1N(W)X/N7605C(W)X

This is a three blade Compact propeller with composite blades for the RV-10 and is immediately identifiable by its wide chord design. Pilot reports indicate that this prop loses some top end speed compared to the 8068. This propeller is also used on the Cirrus SR22(T). When the propeller model number includes a "1" after the shank designation "Y" (ex. HC-C3Y1R-1N), this indicates a Lightweight Compact propeller. Lightweight Compact propellers use a lighter hub assembly and are only available with composite blades.

HC-(C,G,M)3Y(1)R-1N(W)X/N7605C(W)X Attributes

Characteristic	Value
Number of Blades	3
Available Diameters	78"
Typical Extensions	C / G
Weight, Lightweight C/G hub	58 / 60 lbf.
Typical Engine Displacement	540



HC-(C,G)3Y(1)R-1N(W)X/N7605C(W)X

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E. 3C1-(L,R)(430, 675)A1X()/76C(S)03-(2,4,7)X2

The first Raptor propeller introduced to the RV series, this is a three blade propeller with composite blades; designated with the trade name Explorer. For installations with acceptably low vibratory loads as determined by Hartzell engineers, the blades are configured with a lightweight aluminum shank designated as "C" (e.g. 76C03) to save weight; higher load applications utilize stainless steel shanks, designated as "CS" (e.g. 76CS03) and weigh more as a result. This propeller is currently available in several diameters, currently two diameters for 360s/390s and with a smaller diameter for 320 applications. The 430 extension is standard. A longer 675 extension is offered for modified cowlings.

3C1-(L,R)(430, 675)A1X()/76C(S)03-(2,4,7)X2 Attributes

Characteristic	Value
Number of Blades	3
Available Diameters	74" / 72" / 69"
Typical Extensions	430 / 675
Weight, 430 hub, Aluminum/Stainless Steel shanks	42 / 50 lbf.
Typical Engine Displacement	320 / 360 / 390



3C1-(L,R)(430)A1X()/76C(S)03-(2,4,7)X2

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F. 3C1-R430A1X()/76C(S)04X

A new three blade offering for the RV-10, this is a three blade Raptor propeller; designated with the trade name Explorer. For installations with acceptably low vibratory loads as determined by Hartzell engineers, the blades are configured with a lightweight aluminum shank designated as "C" (e.g. 76C04) to save weight; higher load applications utilize stainless steel shanks, designated as "CS" (e.g. 76CS04) and weigh more as a result. Similar to the three blade configured for the 4 cylinder RVs, this one uses a different laminate design for the 540 engine.

3C1-R430A1X()/76C(S)04X2 Attributes

Characteristic	Value
Number of Blades	3
Available Diameters	76"
Typical Extensions	430
Weight, Aluminum/Stainless Steel shanks	42 / 50 lbf.
Typical Engine Displacement	540



3C1-R430A1X()/76C(S)04X

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G. HC-C2YL-1BFX/F7663-4X

This is a two blade compact propeller with aluminum blades. This propeller offers inexpensive performance for 320 equipped aircraft; it's not the newest, or the prettiest, but it works well. While careful attention to knicks and damage is always important, it is especially important for this particular blade design because it is thin and therefore unforgiving of neglect.

HC-C2YL-1BFX/F7663-4X Attributes

Characteristic	Value
Number of Blades	2
Available Diameters	72"
Typical Extensions	C
Weight, C hub	50 lbf.
Typical Engine Displacement	320



HC-C2YL-1BFX/F7663-4X

H. 2C1-R(419, 675)A1X/75CS08(-2)X

Van's Aircraft specifically asked Hartzell to develop a composite two blade propeller to mimic the current RV standard two blade metal propeller, the 7497(-2), commonly referred to as the "blended airfoil" or BA prop. The result is the new 75CS08(-2)X blade design, designed specifically for RVs. The new propeller does what Van's asked us to, it provides similar cruise performance while reducing the installed weight. The second Raptor propeller introduced to the RV series, this is the first application for the 2 blade Raptor design; the Raptor system was applied in order to save as much weight as possible. Due to the ubiquity with which the RV community knows and refers to the standard 7497 as the Blended Airfoil, and that this propeller is intended as a carbon composite counterpart, the tradename for this propeller has been designated as the Carbon Blended Airfoil.

2C1-R(419, 675)A1X/75CS08(-2)X Attributes

Characteristic	Value
Number of Blades	2
Available Diameters (-2)	74" / 72"
Typical Extensions	419 / 675
Weight, 419 hub, Stainless Steel shanks	37.9 lbf.
Typical Engine Displacement	360 / 390

(1) Spinner Compatibility

- (a) This propeller is compatible with the standard spinner components provided with the Van's Aircraft kit. However, the hub mounting holes need to be slightly different. Refer to Figure 1-2, "Spinner Modifications" and/or the 2C1 bulkhead template in the Spinner Templates Section. You'll also want to form the blade cutouts and filler plates differently.



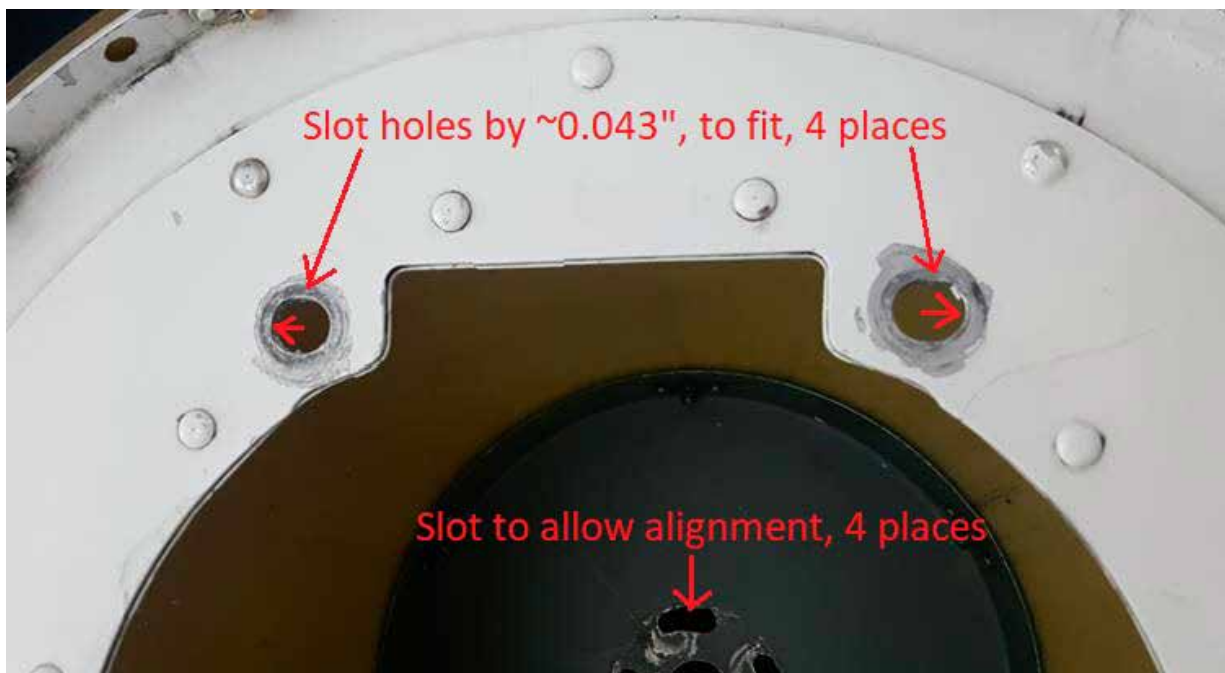
2C1-R(419, 675)A1X/75CS08(-2)X

(b) Spinner Retrofit

- 1 This new propeller requires minimal changes to replace an existing two blade 7497 installation, all centering around reusing the spinner.
 - a If equipped with the original A-2246-4 (1/4") spacers (A-2476-8 mounting kit): 1x 0.032" washer should be added to the spacer stack between the spinner bulkhead and the mounting face of the hub, this will place the spinner in the identical location with respect to the cowling. If equipped with A-2246-3 (5/16") spacers (A-2476-43 mounting kit), no change needed.
 - b The mounting holes in the bulkhead must be slotted by approx. 0.043" outboard radially (perpendicular to the blade) to fit. See Figure 1-2.
 - c The mounting holes in the forward (which attaches to the propeller forward cylinder) must be slotted circumferentially because the hole pattern in the new propeller will not be the same orientation. See Figure 1-2.
 - d The blade cutouts in the dome and filler plates must be checked for adequate clearance and adjusted as needed.

(2) Flight Test Results

- (a) Hartzell conducted flight tests on an RV-8 equipped with a 200 hp, Lycoming IO-360-A1B6 to compare the performance of the new two blade 75CS08-2X (72") propeller vs the current two blade aluminum F7497-2X (72") and current two blade composite N7605C-4X8 (72") propeller.



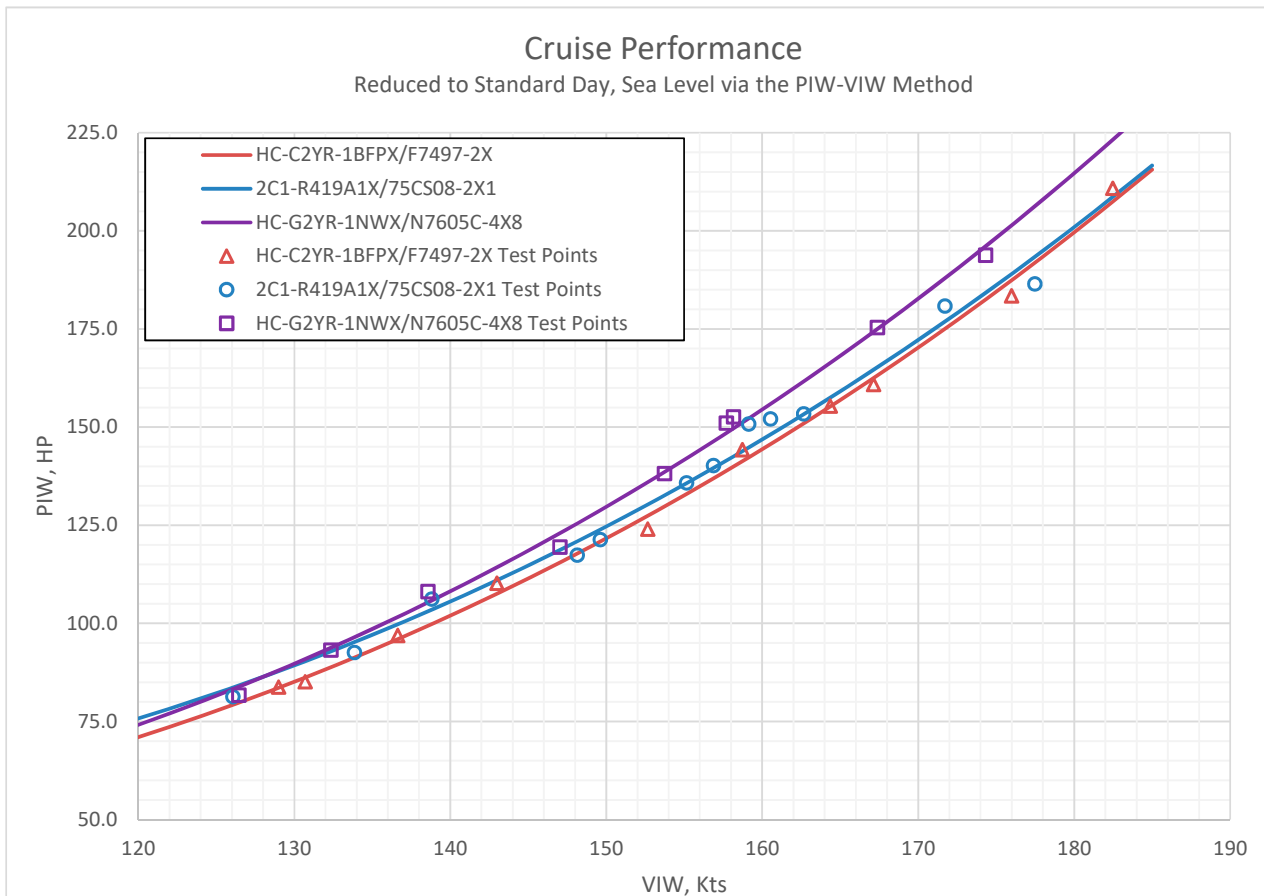
Spinner Modifications
Figure 1-2

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(b) Cruise Performance

- 1 Cruise performance was measured using four leg GPS patterns to correct for wind at multiple power settings at each of three altitudes, see Table 1-1; four leg patterns are used to allow for statistical calculation of true airspeed by using four variations of three legs. Data were reduced using the PIW-VIW method to correct for variations in power, weight, and density; corrected data were then used develop a speed-power polar. As shown in Figure 1-3, testing demonstrated a very similar performance to the aluminum propeller, and better performance than the current composite propeller.

Table 1-1: Cruise Power Setting			
Pressure Altitude	Setting 1 MAP, in-Hg / RPM	Setting 2 MAP, in-Hg / RPM	Setting 3 MAP, in-Hg / RPM
2,000 ft.	28.5 / 2700	~28" / 2500	~27" / 2300
7,500 ft.	WOT / 2700	WOT / 2500	WOT / 2300
12,500 ft.	WOT / 2500	WOT / 2300	WOT / 2100



Blade Cruise Performance Comparison
Figure 1-3

(b) Conclusions

- 1 Flight testing demonstrates similar cruise performance with the new two blade composite 75CS08-2 propeller as compared to the standard 2 blade aluminum 7497 propeller while offering substantial weight savings.

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GOVERNOR BRACKET INSTALLATION - CONTENTS

1. Installing the VA-153-PC Cable Bracket for S-1 Series Governors	2-3
A. Governors with 6 Head Attachment Bolt Locations	2-3
B. Governors with 12 Head Attachment Bolt Locations	2-4

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1. Installing the VA-153-PC Cable Bracket for S-1 Series Governors

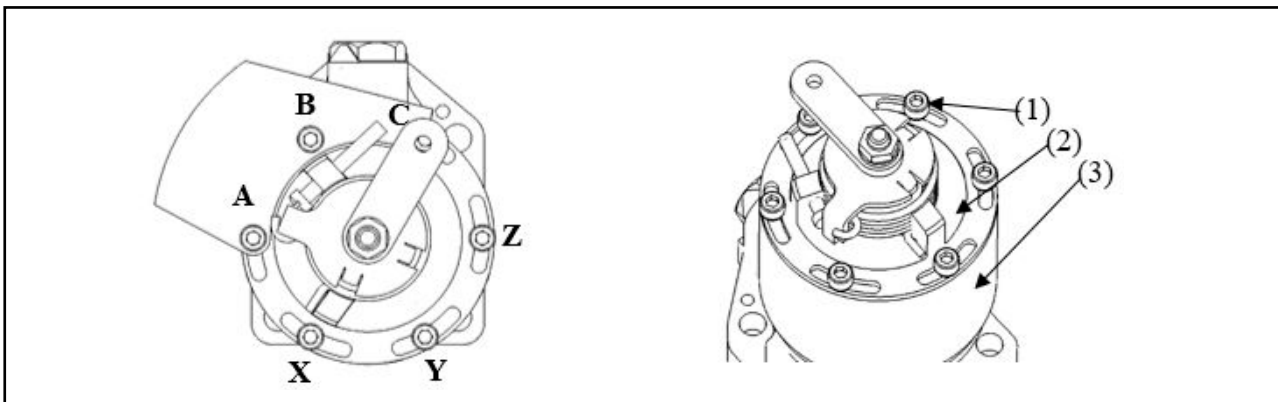
Two sets of instructions follow, one for governors with 6 head attachment bolt locations and one for governors with 12 head attachment bolt locations. Follow one set of instructions as appropriate to the governor. As of this writing, only the S-1-10 has 12 head attachment bolt locations.

A. Governors with 6 Head Attachment Bolt Locations

- (1) Remove and clean the three head mounting screws (1) labeled A, B, and C in Figure 2-1.
 - (a) Clean screws with Loctite 7471 Primer Grade "T" and allow to air dry.
- (2) Place the VA-153-PC Cable Bracket in the desired orientation.
- (3) Mount the bracket using the three head mounting screws previously removed. Apply Loctite 242 to the threads of screws A, B, and C.

NOTE: Only follow Step 4 or Step 5, both are NOT required. Follow instructions per the desired / current control lever position.

- (4) If the control lever is in the desired orientation:
 - (a) After cleaning screws and applying Loctite as noted above in Steps 1 and 3, Torque the head mounting screws (A, B, and C) to 21-25 in-lbs.
- (5) If the control lever angle needs to be adjusted:
 - (a) Install, but do not tighten screws A, B, and C.
 - (b) Remove and clean the three head mounting screws (1) labeled X, Y, and Z.
 - 1 Clean screws with Loctite 7471 Primer Grade "T" and allow to air dry.
 - (c) Rotate the Head (2) in Figure 1 until the desired control lever angle is achieved.
 - (d) Apply Loctite 242 to the threads of screws X, Y, and Z.
 - (e) Torque all of the head mounting screws to 21-25 in-lbs.



Governors with 6 Head Attachment Bolt Locations
Figure 2-1

B. Governors with 12 Head Attachment Bolt Locations (e.g. S-1-10)

- (1) Loosen, but do not remove, the 6 head mounting screws labeled 1 and 6 in Figure 2-2. This will allow the governor head (2) to rotate freely on the governor body (3).
- (2) Rotate the governor head CW until it contacts the head mounting screws. This will reveal 6 additional head mounting screw holes which are labeled A, B, C, X, Y, and Z in Figure 2-3.
- (3) Remove and clean screws 1, 2, and 3 from the governor body (3).
 - (a) Clean screws with Loctite 7471 Primer Grade "T" and allow to air dry.
- (4) Mount the bracket using holes A, B, and C as shown in Figure 2-4. Apply Loctite 242 to the threads of screws 1-3 and install in holes A, B, and C but do not tighten them. Do not install the washers under screws 1-3.
- (5) Remove and clean screws 4, 5, and 6 from governor body (3) and apply Loctite 242 to the threads of screws 4-6. Install in holes X, Y, and Z but do not tighten. See Figure 2-5.
- (6) Rotate the head so the screws are aligned in the middle of the slots as shown in Figure 2-6.
- (7) Torque the head mounting screws to 21-25 in-lbs.

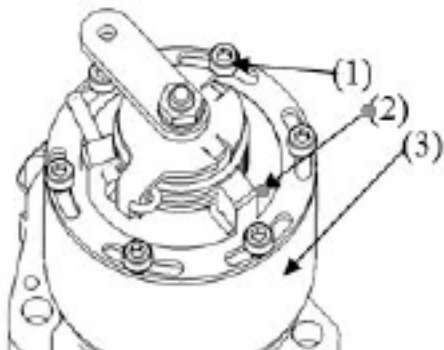


Figure 2-1: S-1-10 Governor

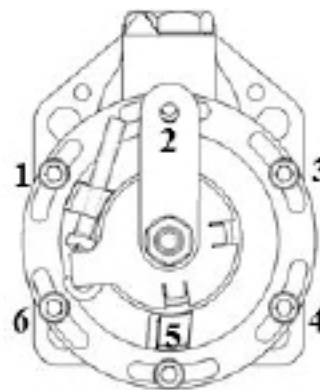


Figure 2-2: Mounting Screw Callout

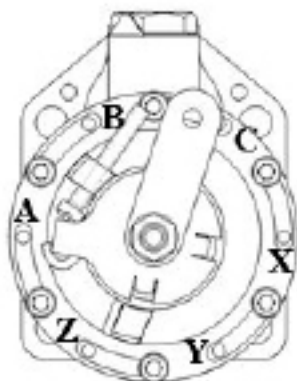


Figure 2-3: Head Rotated

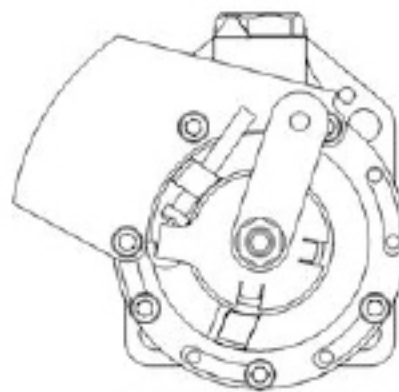


Figure 2-4: Bracket Installed

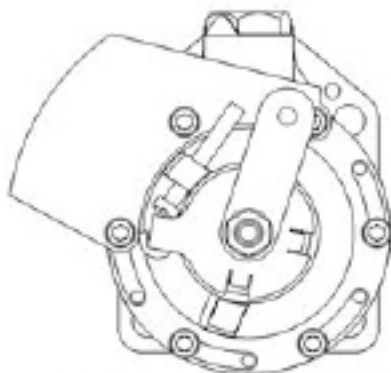


Figure 2-5: Mounting Screws Installed

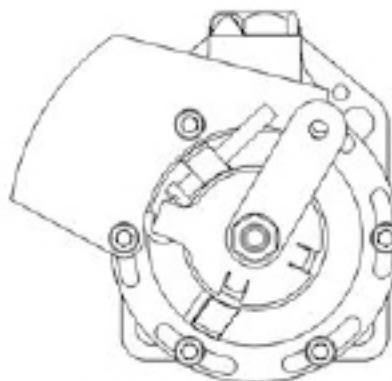


Figure 2-6: Final Configuration

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3D SPINNER/COWLING TOOL - CONTENTS

1. Purpose	3-3
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**HARTZELL PROPELLER MANUAL 193
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1. Purpose

To help homebuilders fit their spinner and cowlings, Hartzell is offering free files for builders to 3D print fixtures to replicate the propeller. These tools comprise several different parts and configurations. Hartzell assumes no liability from the use of these files or parts. Parts may vary from those depicted in this document due to changes in configuration, or incorporation of additional features over time.

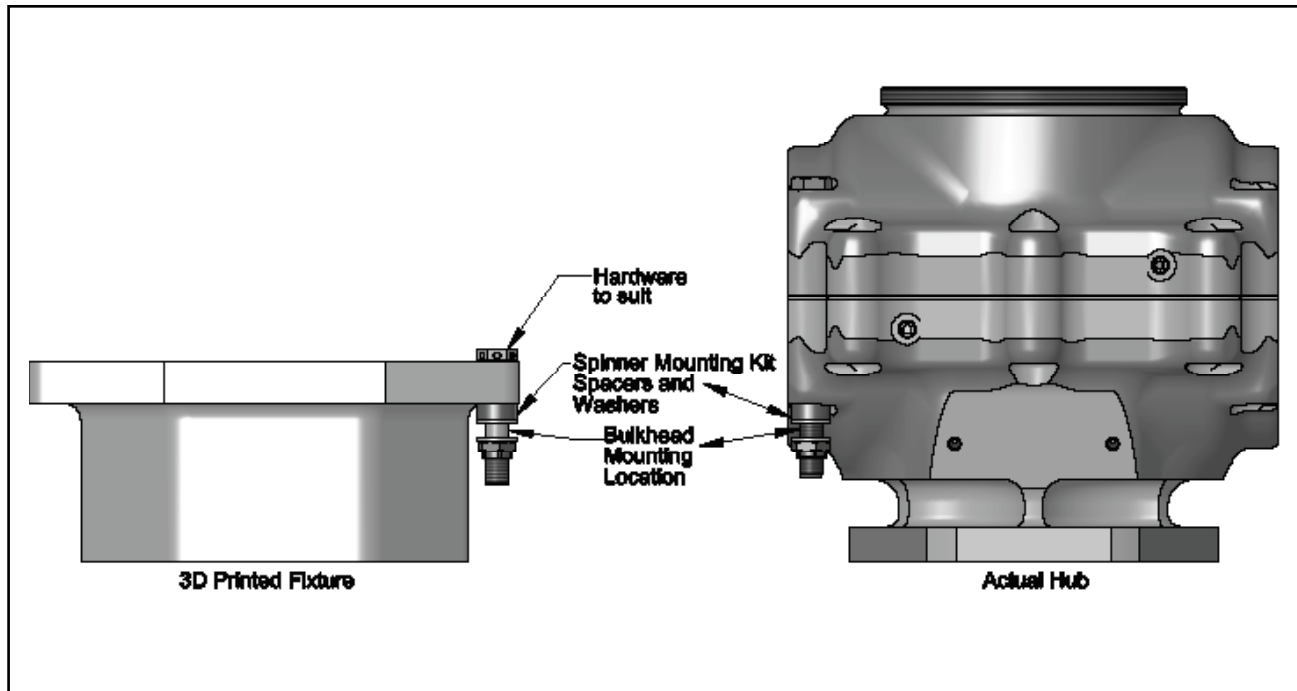
2. Required Hardware

The intent is for the builder to use commonly available hardware, of suitable length and grade, to assemble the fixture therefore exact lengths, types, or part numbers are not specified.

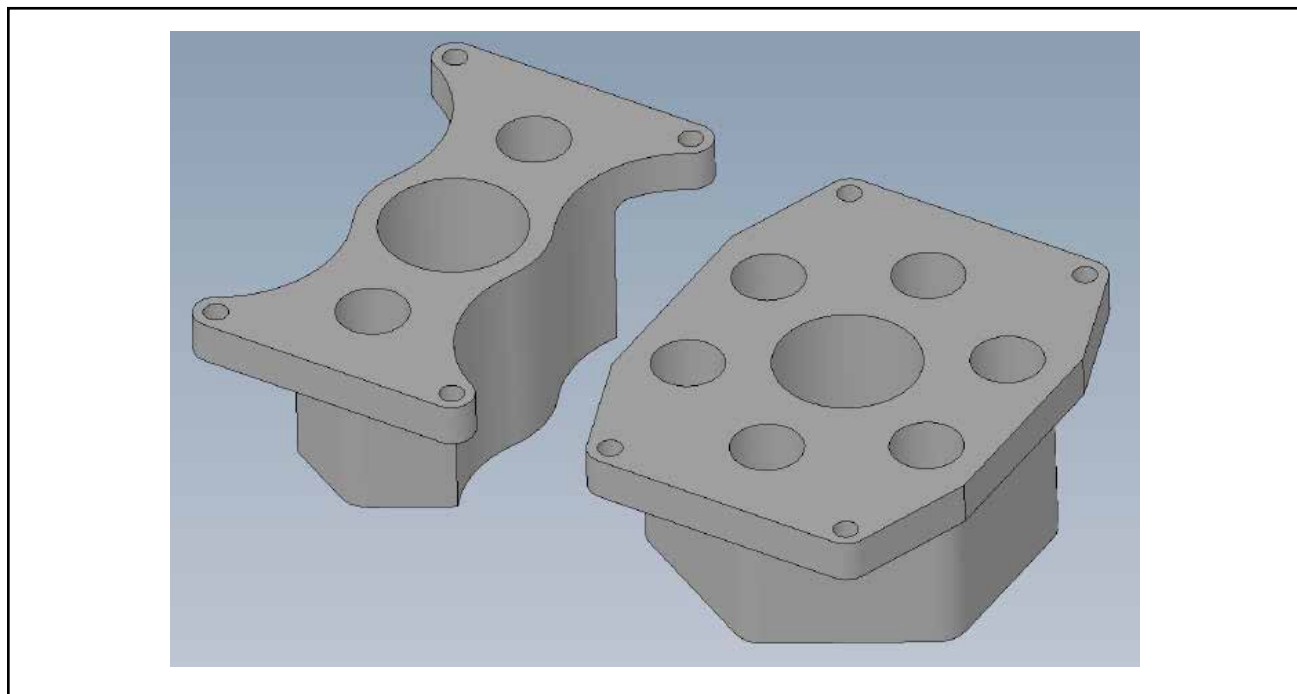
Usage	Size	Quantity
Hub Fixture-to-Engine	Per engine, typ. 1/2"-20	2-6
Hub Fixture-to-Spinner Bulkhead/Backplate	3/8" ID washers/spacers	As required per Aircraft Configuration
Blade Adapter-to-Hub Fixture, per Adapter	3/8"-24 (AN6)	2
Blade Replica-to-Blade Adapter, per Replica	1/4"	1 to attach, 1 for pitch limits
Spinner Forward-to-Cylinder Post	1/4"-28	2-4



**Hub Fixture Attached to Engine
Figure 3-1**



Hub Fixture Example
Figure 3-2



Lightweight vs. Standard Model
Figure 3-3

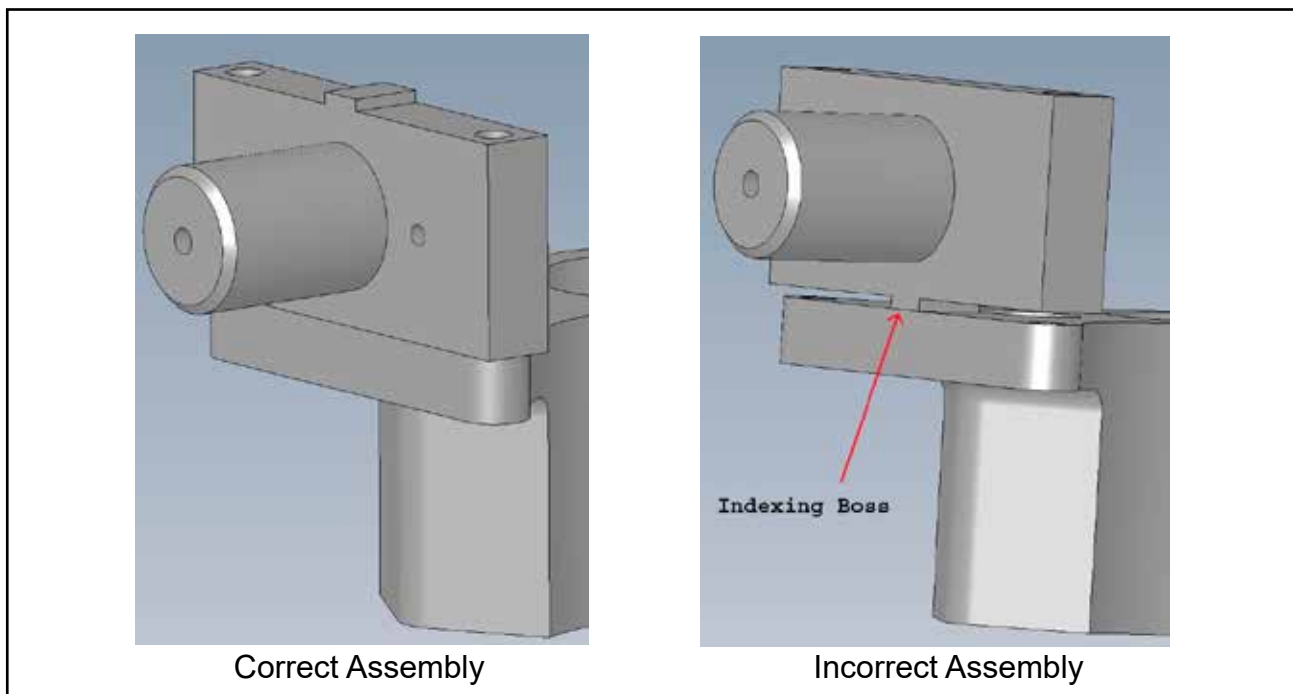
3. Fixture Parts

A. Hub Fixture

The hub fixture is a part to which a spinner, either Hartzell or 3rd party, can be attached and then fixed to the engine to guide cowling installation as shown in Figure 3-1. The mounting holes and distances are appropriate for the labeled hub type, see Figure 3-2 for an example comparison. The builder should use the appropriate spinner mounting kit spacers and washers to locate the spinner bulkhead (backplate) as they would when installed on the hub. Refer to kit instructions and/or Hartzell Manual 159 (Application Guide) for specific configurations and spacer lengths. Fixtures may have a lightweight (LWT) version designed to use less material, refer to Figure 3-3. Hub fixtures will be available for different extensions, blade counts, and propeller series.

B. Blade Adapter

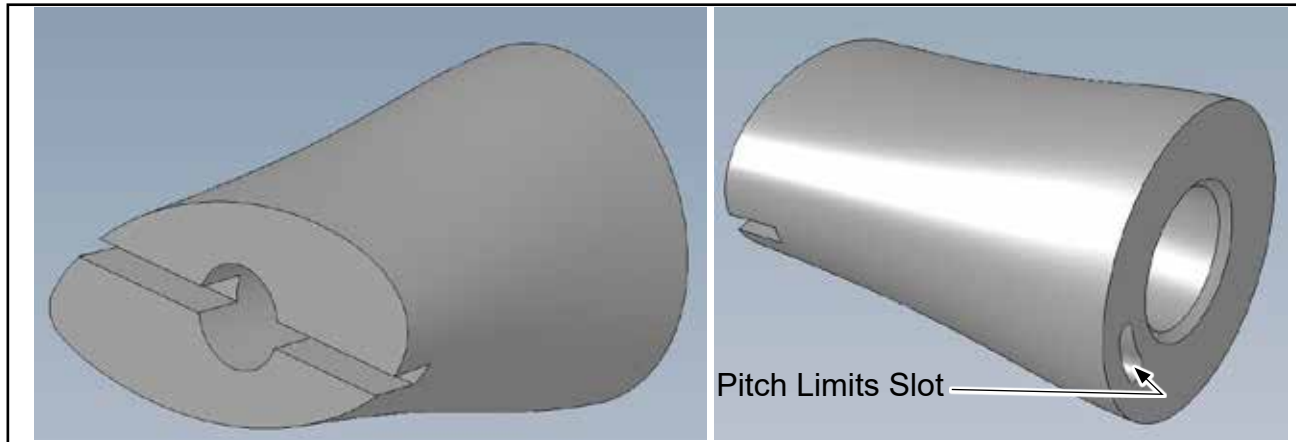
A blade adapter may be added to the hub fixture to allow a blade replica to be attached. These fixtures are specific to the hub series configuration. The adapter attaches to the hub fixture using the spinner bulkhead mounting points, using 3/8" hardware. The adapter uses and accepts 1/4" hardware to attach to a replica blade. It can also use 1/4" hardware as an indexing pin to limit blade angle travel. The adapter has an indexing boss to indicate incorrect assembly orientation by preventing flush attachment to the hub fixture. Refer to Figure 3-4.



Blade Adapter
Figure 3-4

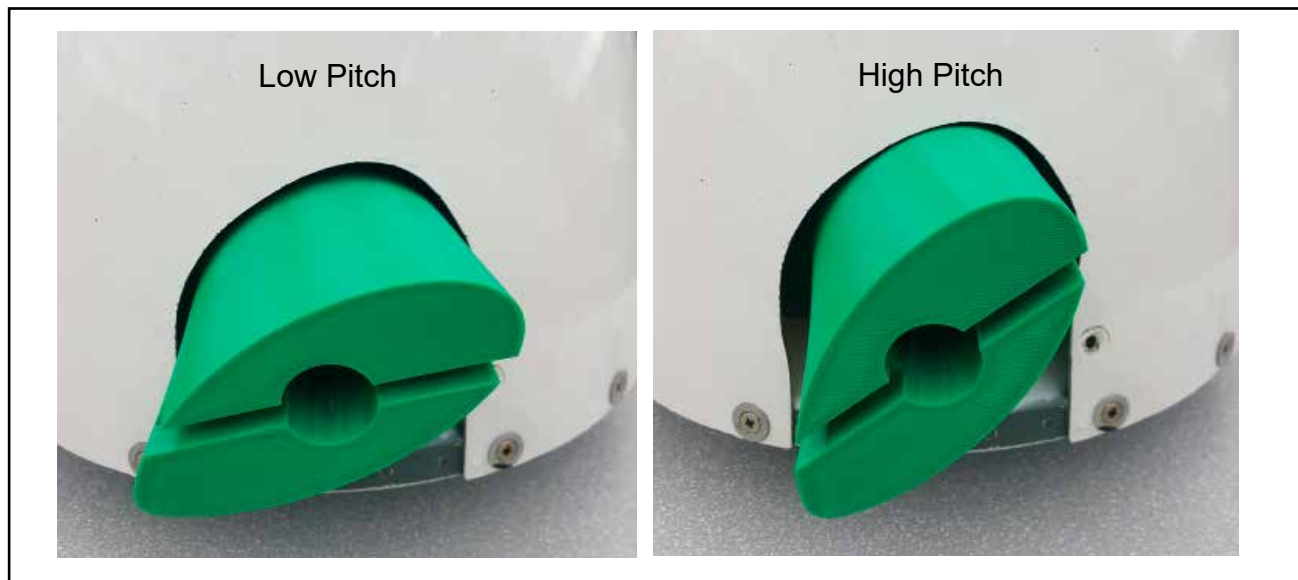
C. Blade Replica

A small blade replica as shown in Figure 3-5 may be added to guide spinner cutout and filler plate shaping. See Manual 193, Volume 2 for more information on pitch settings.



Blade Replica
Figure 3-5

The blade replica needs to sit flush against the blade adapter. The blade replica includes a slot for 1/4" hardware to limit travel from low pitch to high pitch; the slot is on the lead edge side of the blade. The High/Low pitch settings are specific to the installation labeled for the blade replica; the settings can be found in Hartzell Manual 159. Low pitch is user adjustable whereas high pitch is not, so some margin is added to the low pitch setting. Refer to Figure 3-6.



Blade Replica Pitch Limits
Figure 3-6

A 1/4" slot is also provided to allow the builder to affix a flat surface plate (3D printed or other convenient flat stock) against which to measure and set angles; this slot is aligned with the reference location for the installation and sets zero degrees level with the flat of the hub fixture mounting flange. Refer to Figure 3-7.



Flat Stock in Slot

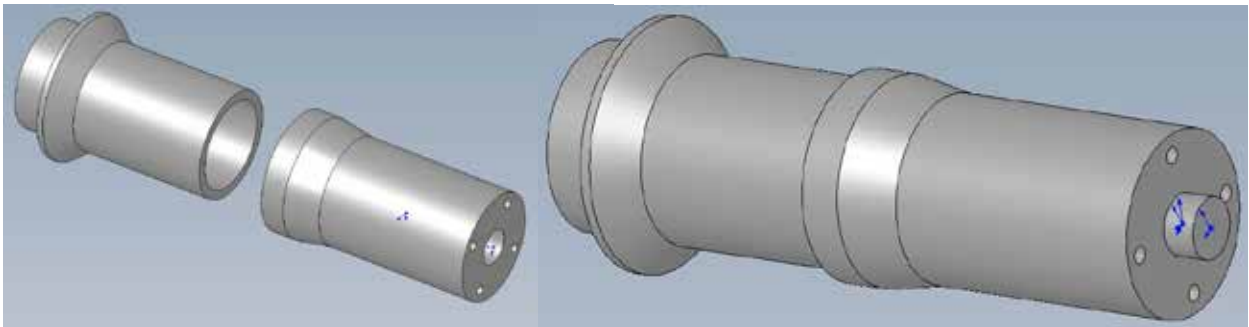


Measurement

Blade Replica Angle Measurement
Figure 3-7

D. Cylinder Post

A post, as shown in Figure 3-8, may be added to simulate the forward location of the cylinder for those spinner designs that use a forward support attached via screws to the propeller cylinder. The length of these posts are specific to the propeller model, and can vary. Cylinders are typically screwed onto the hub, this means that the clocking of the forward attach holes is not guaranteed to be aligned in any particular direction; so wait until final fitment to the specific propeller to match drill holes connecting the spinner dome and forward bulkhead. The fit to the hub fixture is loose, shim with tape for a snug fit. Tap the four end holes for 1/4-28. This part can be long (approx 9 in), so it is supplied as two pieces (A and B suffix) to reduce the height for smaller printers; shim the fit between the two pieces with tape. A third, optional, piece can be installed as a centering fixture for the forward bulkhead.



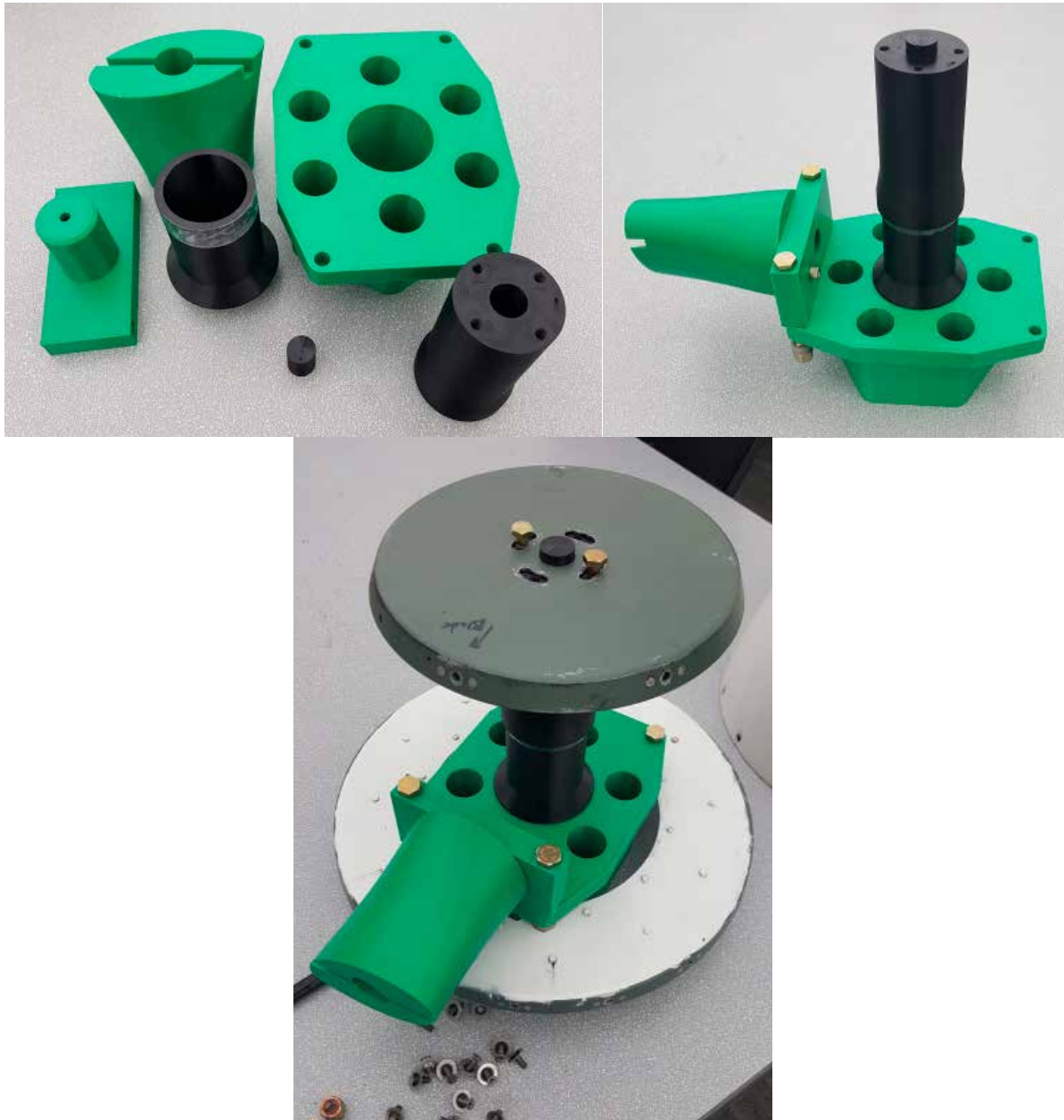
Components

Assembled

Cylinder Post
Figure 3-8

4. Fixture Assembly

Hardware used in the assembly of the fixture components is not critical; commonly available hardware can be used. The spacers and washers (spinner mounting kit) used to set the spinner bulkhead location can be from the propeller itself (do not remove the propeller hub clamping bolts), if available, or dimensionally representative combination of other available spacers and washers. Ensure that the bolts used to hold the blade adapter and spinner bulkhead are firmly snugged. Refer to Figure 3-9.



Fixture Assembly
Figure 3-9

5. Recommendations

A. Selecting the Correct Files

Files are named using the appropriate descriptors for the propeller model and/or blade model. Refer to the Propeller Configuration Section in Manual 193, Volume 2 for detailed descriptions of propeller series model designations and/or the appropriate propeller Owner's Manual to assist with selecting the correct files.

B. Gaps

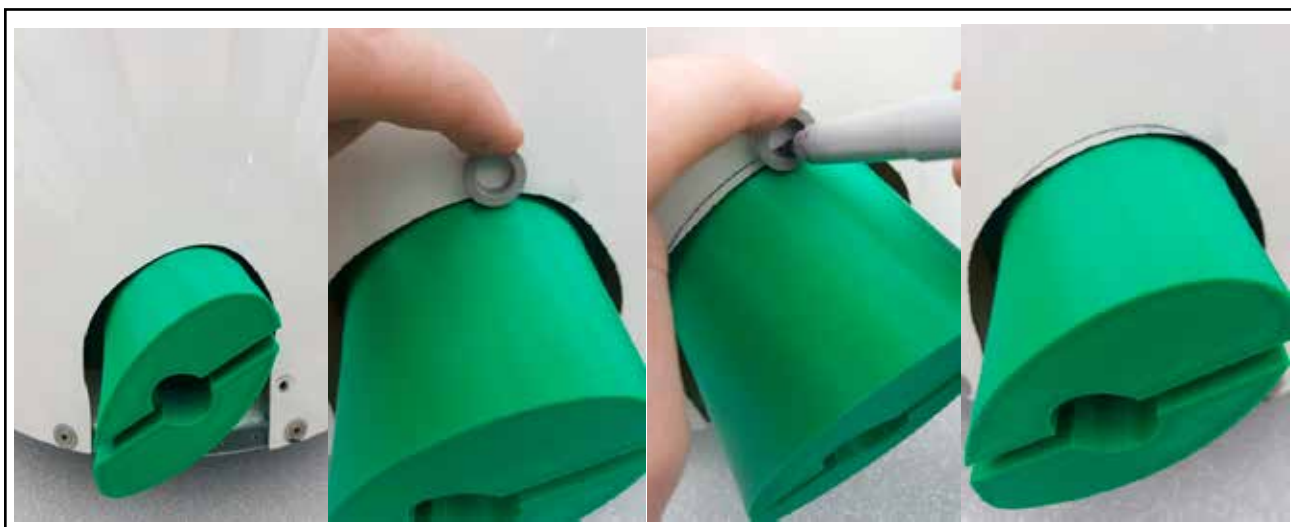
(1) Cowling-to-Spinner

Hartzell recommends a minimum longitudinal (fore/aft) cowling-to-spinner gap of 0.250", and a radial gap (if applicable based on cowling shape, inlets, etc) of 0.500". Engine mount isolators tend to allow the engine to sag over time, and the cowling may not be as rigid in flight as it appears on the ground; increased gap allows these variations without interference or repair.

NOTE: Some spinner domes overhang the edge of the bulkhead, rather than sitting flush. Take this into account, or install the dome, when fitting up with these spinners.

(2) Spinner-to-Blades

Hartzell recommends a 3/16" gap between the spinner and blades at all blade angle positions. This gap must be no smaller than 0.125". Recheck this gap any time the low pitch angle is adjusted. A washer or spacer makes a convenient offset gage to transfer the blade profile onto the dome or a template with desired clearance by rolling the spacer or washer along the blade with a marker on the inside of the spacer/washer as shown in Figure 3-10.



Spinner-to-Blade Clearance
Figure 3-10

C. Forward Supports

The propeller cylinder holes do not have a guaranteed clocking, so wait until assembly onto the actual propeller to match drill forward supports to the dome.

D. Spinner Mounting Kit

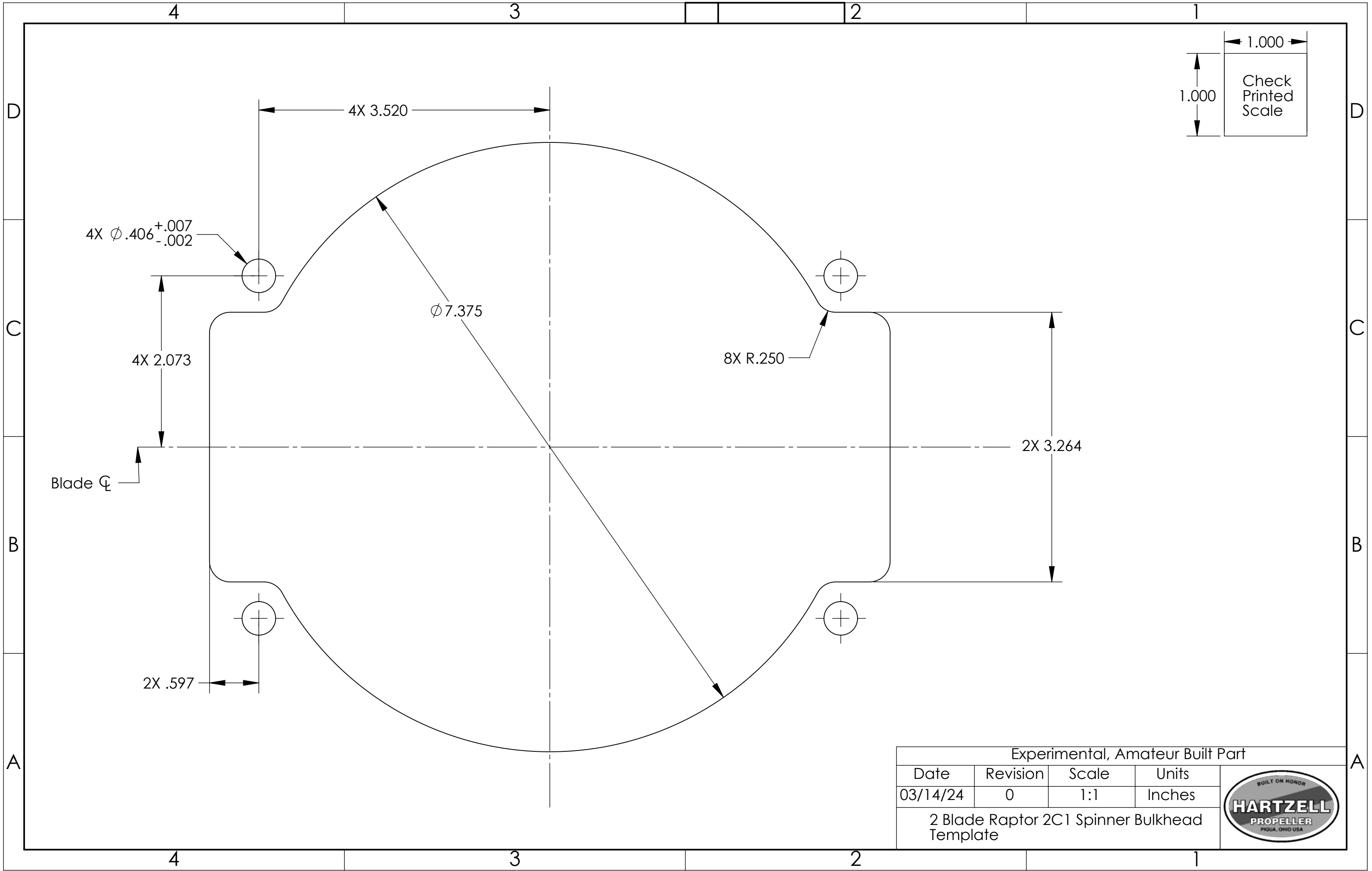
When using the fixture to set cowling gaps, check that you're not at the extreme end of the spinner mounting kit, i.e. right up against the hub or fully extended; leave some adjustability in the form of adding or subtracting washers to dial in the final fit. See Manual 193, Volume 2 and Manual 159 for more information on spinner mounting kits.

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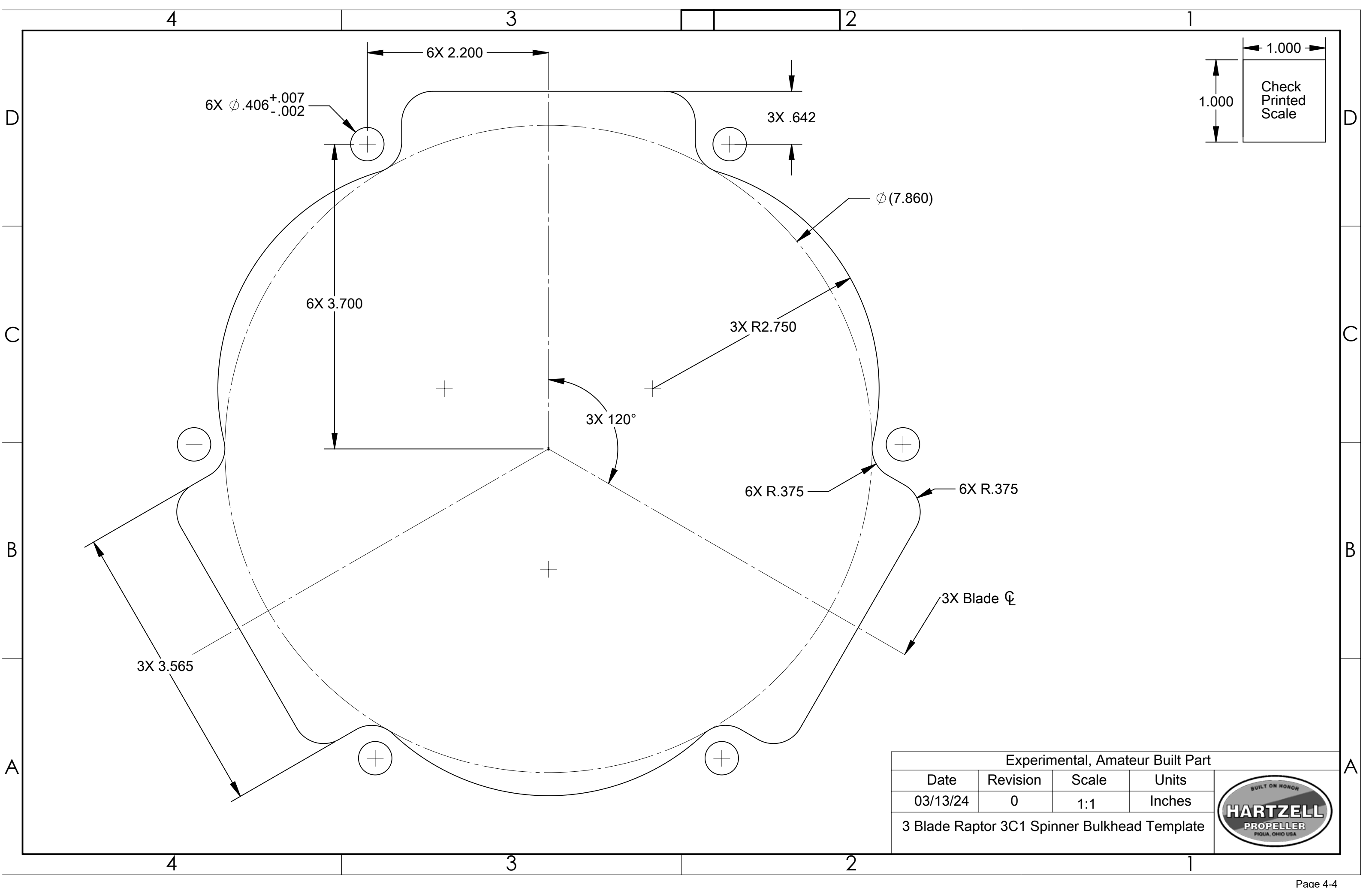
SPINNER TEMPLATES - CONTENTS

2-blade Raptor 2C1 Spinner Bulkhead Template.....	4-3
3-blade Raptor 3C1 Spinner Bulkhead Template.....	4-4
2-blade Compact Spinner Bulkhead Template: HC-()2YR.....	4-5

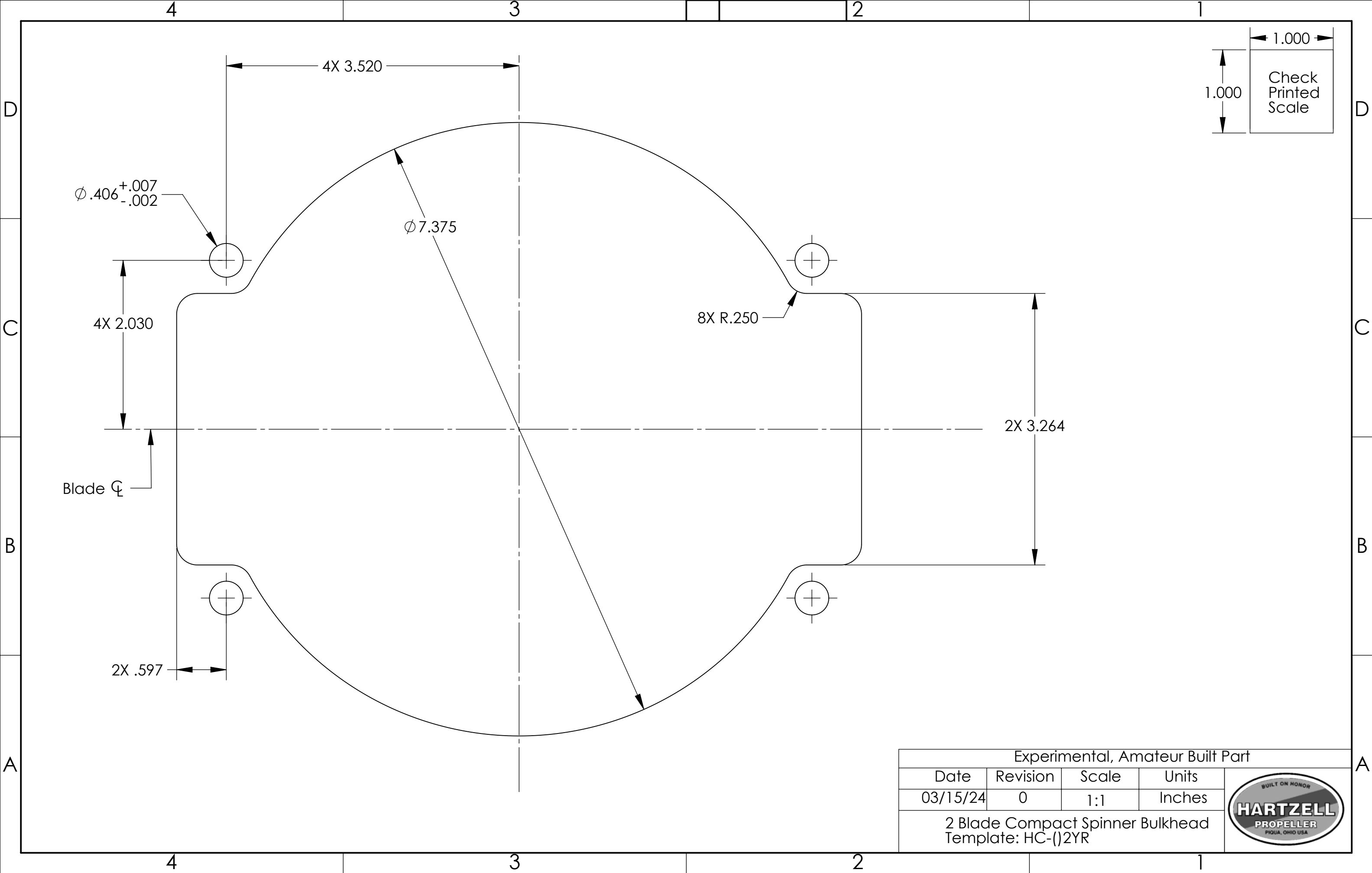
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Experimental, Amateur Built Part				
Date	Revision	Scale	Units	
03/14/24	0	1:1	Inches	
2 Blade Raptor 2C1 Spinner Bulkhead Template				



Experimental, Amateur Built Part			
Date	Revision	Scale	Units
03/13/24	0	1:1	Inches
3 Blade Raptor 3C1 Spinner Bulkhead Template			



Experimental, Amateur Built Part				
Date	Revision	Scale	Units	
03/15/24	0	1:1	Inches	
2 Blade Compact Spinner Bulkhead Template: HC-()2YR				

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