

## RV - CLASS OWNER - MAINTAINER CHEAT SHEET

*Numbers, Limits, and Rules a Builder and Owner of an Aluminum Experimental Should Carry Forever*

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*Research conducted by AI agents (Claude, Anthropic) under human direction.  
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## 1. FASTENER DECODING

### 1.1 AN / MS / NAS PREFIX SYSTEM

| Prefix | What it is   | Example       |
|--------|--|---------------|
| AN     | Army-Navy, the historical standard                       | AN3-5A bolt   |
| MS     | Military Standard, the AN successor                      | MS24694 screw |
| NAS    | National Aerospace Standard, higher-performance variants | NAS1304 bolt  |

### 1.2 AN BOLT CALL-OUT (AN3 THROUGH AN20 SERIES)

AN3-5A decodes as: AN3 → bolt diameter 3/16" (i.e. #3 = 3/16); -5 → grip length 5/8" (the first digit is eighths, the second sixteenths; -5 means 5/8 even); A → drilled shank for cotter pin if applicable, undrilled if -5 alone (the A or absence of A is the drilled-shank indicator on some series; verify per AC 43.13-1B Table 7-1). Bolt diameter increments by 1/16" per AN number (AN3 = 3/16, AN4 = 1/4, AN5 = 5/16, AN6 = 3/8).

**Rule of thumb on grip length:** the threads must clear the joint — never load threads in shear. Grip length is the unthreaded shank portion. Add one or two washers under the nut to take up slop and to put the threads outside the joint. Self-locking nuts (MS21042) must show at least one full thread above the nut.

### 1.3 RIVET CALL-OUTS

| Code                    | Material                 | Head             | Diameter   | Length              |
|-------------------------|--------------------------|------------------|------------|---------------------|
| AN426 / MS20426 AD3-3.5 | 2117-T4 aluminum (AD)    | Countersunk 100° | 3/32"      | -3.5 = 7/32" length |
| AN470 / MS20470 AD4-5   | 2117-T4 aluminum         | Universal        | 1/8"       | -5 = 5/16" length   |
| MS20426 D               | 2024-T4 (D — heat-treat) | Countersunk      | per number | per number          |
| MS20470 DD              | 2024-T4 (DD — ice-box)   | Universal        |            |                     |

The PI's RV-8 uses overwhelmingly AD-rivets (the soft 2117 alloy) because they are formed at room temperature. DD rivets must be kept frozen and used quickly after thaw, and are reserved for spar-attach work where higher shear strength is required.

**Diameter codes (the digit after AD or DD):** 3 = 3/32", 4 = 1/8", 5 = 5/32", 6 = 3/16".

**Length codes (the digit after the dash):** the digit is sixteenths of an inch. AD3-3.5 means 3.5/16" = 7/32" overall length.

**The shop-head rule.** A properly set solid rivet has a shop head whose diameter is approximately **1.5 times the rivet shank diameter** and whose height is approximately **0.5 times the shank diameter**. For an AD3 (3/32" = 0.094"): shop head diameter ≈ 0.141", shop head height ≈ 0.047". Use a rivet gauge. Anything outside ±10% on diameter or ±15% on height is suspect; smoking, cracked, tipped, or off-center heads are *always* failures. Drill it out.

**Drilling out a rivet** (AC 43.13-1B Chapter 4-8): centerpunch the manufactured head; drill a pilot hole the size of the rivet shank *into the head only*; pop the head off with a small punch; punch the remaining shank out. Do **not** drill all the way through — you will enlarge the hole and forfeit edge distance.

## 1.4 PULLED / BLIND RIVETS

For locations without backside access: Cherry CR3213 (or MS20600 equivalents), Avex (the most common pulled rivet in RV work; the Avex 1601 series), Cherrymax (premium structural blind). Cherry and Avex are visually distinct (Avex shaves a small dome head; Cherry retains a flush look). The plans call out blind-rivet sites explicitly; never substitute blind for solid in a structural joint that calls for solid.

## 1.5 NUTPLATES AND WASHERS

| Part                         | What                         | Notes  |
|------------------------------|------------------------------|--|
| K1000-3 / -4 / -5 / -6 / -08 | The Van's nutplate inventory | K1000-3 = 3/32 rivet attach; numbers correspond to thread size         |
| MS21051-L3 / Lo6 / Lo8       | One-lug nutplates            | The L prefix = single-lug; used at edge-distance-constrained locations |
| MS21053                      | Anchor nuts, larger          | Heavy-duty applications  |
| AN960                        | Flat washers                 | -10 (#10), -416 (1/4"), -616 (3/8"); the -L suffix = thin (light)      |
| AN970                        | Large-area washers           | Distributes load on aluminum   |
| MS21042                      | All-metal self-locking nuts  | Aviation standard, replace MS20365 in most current call-outs           |

## 2. SHEET METAL CALL-OUTS

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### 2.1 ALLOYS

- **2024-T3** — primary structure aluminum, “duralumin family”, high strength, age-hardened. The skins, spars, and ribs. - **6061-T6** — softer, easier to form, weldable, used in non-structural and machined parts. - **5052-H32** — formable, corrosion-resistant, used in fuel-tank parts (the integral wing tanks).

The Van’s plans call out the alloy on each part; respect it. 6061 is **not** acceptable as a 2024 substitute in primary structure.

### 2.2 EDGE-DISTANCE AND RIVET-SPACING RULES (AC 43.13-1B CHAPTER 4)

- **Minimum edge distance:**  $2\times$  rivet diameter from the rivet centerline to the part edge. For an AD3 ( $3/32$ "), that is  $3/16$ " minimum. Closer than  $2D$  risks the rivet tearing out under load. - **Standard edge distance:**  $2.5\times$  rivet diameter. - **Rivet pitch (centerline to centerline):** minimum  $3\times$  rivet diameter, typical  $4-6\times$  for skin work, up to  $10\times$  for stitch fastening. - **Hole oversize tolerance:** the rivet shank is sized to be a snug fit in the drilled hole. A #40 drill ( $0.098$ ") for an AD3 ( $0.094$ ") — the  $0.004$ " margin is the working tolerance. If a hole goes substantially oversize, the recovery is upsizing the rivet (one size up) or replacing the part.

### 2.3 BEND RADIUS RULES

Minimum bend radius for 2024-T3 in the as-received condition is roughly  $3\times$  the material thickness; for the more easily formed 6061-O it can be closer to  $1\times$ . Tight bends will crack the outer fiber. Heat treatment can soften 2024 for bending and then re-temper it (an industrial operation) but this is outside the amateur builder’s normal envelope.

### 2.4 DEBURRING

Every cut edge must be deburred. Vixen file for outer edges; Scotch-Brite wheel for rapid bulk work; the Cleaveland 6" deburring wheel for production speed. Hole deburring with a #30/#40 countersink cutter, hand-spun (never powered for a #40 hole — you’ll enlarge it).

### 2.5 DIMPLING

Every flush-rivet hole through  $\geq 0.025$ " sheet gets dimpled before riveting. The DRDT-2 (the PI owns this) is the workhorse for flat work; a pneumatic squeezer with dimple dies handles curved areas; the C-frame is rare in modern RV building.

**Standard dimple dies for the kit:**  $3/32$ ",  $1/8$ " male/female pairs in the squeezer; the DRDT-2 takes the same dies.

### 3 . ACCEPTABLE WORKMANSHIP REFERENCES

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**AC 43.13-1B Change 1, Chapter 4** is the FAA's chapter on metal structures: rivet installation, edge distance, hole preparation, oversize repairs. Read it once at the start of the build; reread the relevant section before every new operation.

**Chapter 5** covers fabric and wood — skip for an aluminum RV.

**Chapter 7** covers aircraft hardware — torque tables, fastener call-outs, the AN-series flare-fitting torque values, and the all-important table that distinguishes “lubricated” from “dry” torque. (The lubrication state changes the torque value substantially — never use an automotive torque without checking which condition is specified.)

**Chapter 11** covers electrical — wire sizing, bundle support, splice acceptability. The Nuckolls *AeroElectric Connection* goes deeper.

**Chapter 8** covers engine mounts and accessories — the primary FAA reference for FWF work that is not in the Lycoming manual.

## 4. ENGINE VITAL SIGNS — LYCOMING O-/IO-360 REDLINES AND NORMAL CRUISE

| Parameter                       | Redline   | Normal cruise               |
|---------------------------------|---|-----------------------------|
| RPM                             | 2700 (most variants)  | 2200–2500                   |
| Cylinder Head Temperature (CHT) | 500°F redline (Lycoming SI 1108B)   | 350–400°F cruise            |
| Oil temperature                 | 245°F redline (most -360 variants)  | 180–220°F cruise            |
| Oil pressure                    | 25 (idle) to 95 (cold start) psi  | 60–90 cruise                |
| Manifold Pressure               | wide-open throttle = field elevation -1"/1000ft   | cruise setting (e.g. 10.5") |
| Mixture / fuel flow             | sea-level full power ≈ 14–17 gph (IO-360 angle valve), 10–13 (parallel/carb), proportionally less at altitude |                             |
| EGT                             | no absolute redline; peak EGT is the diagnostic   | LOP: 10–50°F lean           |
| GAMI spread                     | n/a   | <1 gph for fuel-injection   |

### 4.1 RUN-UP CHECKS

Magneto check at the run-up RPM specified in the airframe POH (typically 1700–1800 for fixed-pitch, 2000+ for constant-speed): switch from BOTH to L, note RPM drop, return to BOTH, switch to R, note RPM drop, return to BOTH.

- **Smooth small drop on each (50–125 rpm):** healthy. - **Smooth large drop (>175 rpm) on one mag:** likely fouled plug on the affected side. Lean aggressively at high power for a minute, then re-check. - **Rough drop:** ignition fault on the affected side — timing, plug, lead, or coil. Investigate before flight. - **No drop at all on a mag:** the P-lead is grounded (the magneto isn't actually being switched off) — DO NOT FLY. The propeller is live.

### 4.2 HOT-START (FUEL-INJECTED LYCOMING)

The vapor in the lines after a hot shutdown will not start without purging. - **Throttle wide open, mixture idle cutoff, fuel pump ON 30–60 seconds to purge the lines back to the tank.** - Pump off, mixture idle cutoff, throttle cracked (1/4"), crank. - As engine fires, advance mixture to full rich.

## 5. CONDITION INSPECTION SHORT LIST (PER FAR 43 APPENDIX D AS ADAPTED FOR EXPERIMENTALS)

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The amateur-built experimental's Condition Inspection is performed by the holder of the Experimental Amateur-Built Repairman Certificate (the builder) or by an A&P, once every twelve calendar months. The checklist below is the high-yield subset; the full FAR 43 Appendix D items remain authoritative.

1. **Cabin and cockpit.** Seat tracks, belts, hardware. Controls free and correct. 2. **Engine inspection (cowl off, plugs out).** - Differential compression check on each cylinder (procedure per Continental SB 03-3 / Lycoming SI 1191A, adapted for the Lycoming). Numbers below 60/80 on a cold engine warrant follow-up; the *trend* matters more than any single number. - Borescope each cylinder bore and exhaust valve. The exhaust valve is the canonical wear-out item; a healthy exhaust valve face is uniformly colored, no green/yellow streaking. The Mike Busch borescope material is the reference. - Oil analysis pulled at every oil change is the year-over-year trend instrument. Spectrographic metals: iron, aluminum, chrome, lead. Trends matter, not single samples. - Oil suction screen (and filter element) inspection — per Lycoming SB 480F. Cut the filter, inspect the pleats for ferrous material. - Plug inspection — color, gap, electrode condition; rotate top-bottom each side at every plug service. - Magneto timing check. - Hose condition — fuel, oil, all flexible lines; replace at the SB 1191A recommended interval or earlier on visible distress. - Baffle seals — silicone or rubber; missing seal = bad CHT distribution. 3. **Propeller and spinner.** Track. Crack inspection (especially leading edges of fixed-pitch metal props). Bolt torque check (Hartzell BA constant-speed: re-torque per Hartzell SB 137). 4. **Landing gear.** Wheel bearings repack. Brake pad wear. Brake fluid level and absence of leaks. 5. **Airframe.** Hinge wear on control surfaces. Skin cracks — the empennage skins are the watch-list area on RVs (the HS-411A/B and the rudder skin trailing edges). Loose rivets — any smoking head, drill out and replace. Antenna mounts. Fuel-cap O-rings. 6. **Avionics and electrical.** ADS-B and transponder bench check (the FAA's biennial requirements remain; verify next due date). Battery capacity check. ELT battery and self-test.

# 6

## 6. THE “WHERE TO LOOK IN WHICH BOOK” INDEX

| Question                              | Primary reference   | Backup                                    |
|---------------------------------------|---|---|
| Dimple die geometry / shop technique  | Bingelis <i>Sportplane Construction Techniques</i> Ch. on sheet metal                               | Van's manual Section 5; AC 43.13-1B Ch. 4 |
| Acceptable rivet appearance           | AC 43.13-1B Ch. 4; Van's Section 5  | Bingelis <i>Sportplane Builder</i>        |
| AN-bolt torque values                 | AC 43.13-1B Ch. 7, Table 7-1  | Lycoming Service Manual for               |
| AN-flare torque (lines, fittings)     | AC 43.13-1B Ch. 9, Table 9-2  | Vendor torque specs trump g               |
| ProSeal / fuel-tank-sealing technique | Bingelis (passing); Van's Section 7 (wing tanks); Vansairforce thread “Tank sealing FAQ”            | PR-1422 / PR-1440 data sheet              |
| Electrical bus architecture           | Nuckolls <i>AeroElectric Connection</i> , current Z-figure (Z-13/8 for single alternator + standby) | AC 43.13-1B Ch. 11                        |
| Wire sizing and bundle support        | AC 43.13-1B Ch. 11  | Nuckolls Ch. 8                            |
| FWF installation general              | Bingelis <i>Firewall Forward</i>  | Van's Section 11; Lycoming C              |
| Lycoming break-in protocol            | Lycoming SSP-700-A “Engine Break-In and Operation”; SI 1014   | Mike Busch <i>Engines</i> Ch. on b        |
| Engine condition monitoring           | Mike Busch <i>Engines</i> Ch. on borescopes and oil analysis  | Lycoming SI 1191A on differ               |
| Mag drop diagnosis                    | Lycoming O&M Manual; <i>Firewall Forward</i>  | APS / GAMI / Deakin materi                |
| Garmin G3X wiring                     | Garmin G3X Installation Manual (current)  | Nuckolls Z-figure for the bus             |
| Phase I flight test plan              | EAA Flight Test Manual; AC 90-89B   | Van's Section 13 FAQ; Aircra              |
| Repairman Certificate application     | FAA Order 8130.2 (current); 14 CFR 65.104; AC 20-27G  | Local DAR will walk you thro              |
| Condition Inspection items            | FAR 43 Appendix D   | Mike Busch <i>Ownership Vol. 1</i>        |
| Vans service letters and bulletins    | vansaircraft.com → support → service info   | The current Van's customer se             |

## 7. THE 12 THINGS TO KEEP ABSOLUTELY CURRENT

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1. **Annual Condition Inspection sign-off** (calendar year)
2. **ADS-B / transponder bench check** (24 calendar months)
3. **ELT battery** (per ELT manufacturer schedule and FAA requirement)
4. **Pitot-static system** (24 calendar months, if IFR)
5. **Oil change and filter cut** (every 25–50 hours per Lycoming SB 480F)
6. **Oil analysis** (at every oil change is ideal; minimum quarterly)
7. **Engine monitor data dump** (after every flight if possible; minimum monthly to Savvy Analysis)
8. **Battery capacity check** (annual)
9. **Magneto 500-hour internal inspection** (per Slick / Bendix SB)
10. **Hose replacement schedule** (per Lycoming SI; typically not on a hard interval for experimentals, but track visually each Condition)
11. **Prop bolt torque** (per Hartzell SB, typically 100-hr / annual)
12. **Tire and brake pad inspection** (preflight habit; documented at every Condition Inspection)

## 8. THE SMELL TEST — WHEN SOMETHING HAS GONE WRONG

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A short list of conditions that mean **stop and investigate**, not “watch and see”:

- Smoking rivet head (always drill out) - Hairline crack at any rivet edge in primary structure - Smell of fuel anywhere in flight - Oil temperature climbing through 220°F on a cool day at cruise - Oil pressure variation correlating with any other parameter (yaw, pitch, throttle) - Any sudden change in EGT trend across multiple cylinders (likely engine-wide: timing, induction, mixture distribution) - A single CHT 30°F+ above the rest (likely baffle leak or injector clog) - Any in-flight electrical event you cannot immediately diagnose (load-shed and land) - Anything that surprises you. Surprises in aviation are not “interesting”; they are diagnostic of a model that does not match reality.

The principle that runs through this whole sheet: **the airplane gives you information continuously. The job of the owner-maintainer is to be the kind of person who can read it.**