Operations Specification Document

FOR THE

AS350 ARRIEL 1 ENGINE

Revision F – July 15th, 2025
- Added a new note to the General Information Pg.9

This document describes in detail the operation of the AKV Arriel 1 Cycle Counter kit P/N 350NGTEC for the AS350.

NOTE: When installing the AKV cycle counter for the first time in an existing airframe, reference EASA AD 2012-0187 for requirements on re-calculating prior recorded Np Cycles.

As a SAFRAN (formally Turbomeca) validated cycle counting aid, the cycle counter's primary objective is to accurately monitor and record both the Ng (Gas Producer) and Np (Power Turbine) engine cycles in accordance with SAFRAN Engineering, France "Linear Interpolation" methodology.

Cycle Counter part number and model applicability:

- P/N 350NGTEC for the Arriel 1B, 1D and 1D1

WARNING: Prior to resetting the cycle counter, a **"Daily Coherence"** check of the accumulated cycles must be completed by the pilot. Ref. the Instructions for Continued Airworthiness (ICA) document no. AS350 Arriel-ICA Rev B or later FAA approved ICA.

Each **ITEM 1-13** below identifies what items are recorded as displayed on the cycle counter screen(s). See Fig 1, page 2 "Screen Layout"

1. Power up screen
2. Ng, Np speeds and Ng Max
3. Ng (Gas producer) flight cycles
4. Np (Free Turbine) flight cycles
5. Engine starts
6. Ng Operations
7. Np Operations
8. Ng total
9. Np total
10. Flight (Flt) time
11. Run time

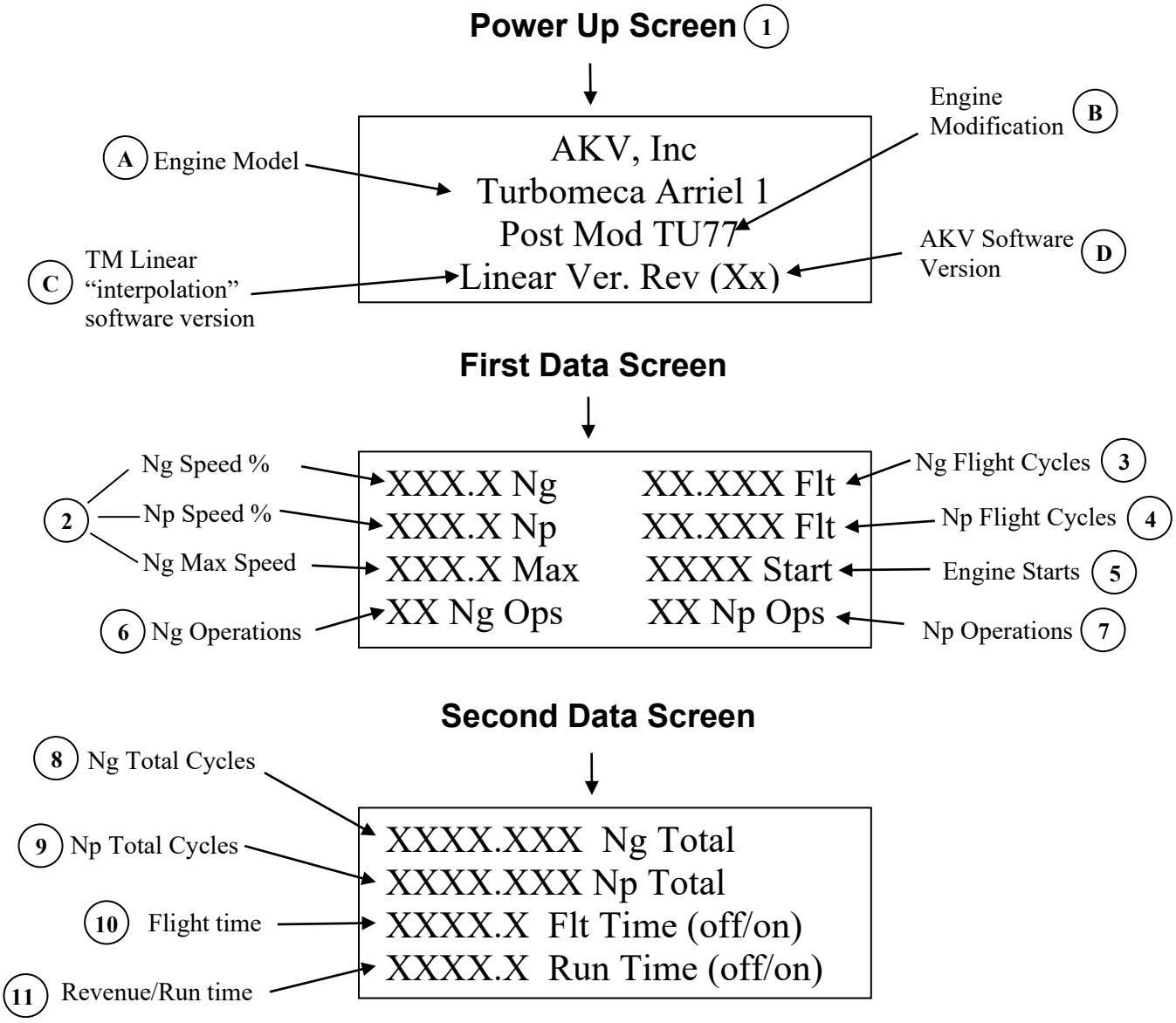


Fig. 1 - **Screen Layout**

ITEM 1 – "Power up" screen

After the A/C Battery is turned on, the power up display screen provides *engine model (A)* by indicating "**Turbomeca Arriel 1**" for the 1B, 1D & 1D1 engine.

The *engine modification (B)* is identified as either "**Pre (or) Post Mod TU77**" which indicates either PRE (Arriel 1B) or POST TU77 (Arriel 1B, 1D, 1D1) software is installed. According to the indication Pre or Post Mod TU77, a different value is added during a partial cycle of the Np section. Further operation description of this operation can be found in item 4. The customer can select which software applies to their engine and program the cycle counter via the Ground Support Equipment (GSE) programming kit.

Confirmation that the system is based on the *TM Linear interpolation software version (C)* methodology is indicated by "**Linear Ver**."

The AKV *software revision (D)* identified as "**Rev (Xx)**" indicates the AKV software revision installed in the cycle counter. The "X" (number) indicates a major change to the cycle counting algorithm whereas as the "x" (lower case alphabet) will indicate a software change that has been made for basic bug fixes or a minor changes that does not affect the cycle counting.

NOTE: The **optional Ground Support Programming Kit P/N CC-GSE** allows for maintenance to program the cycle counter with the current engine totals from the log books as well as install software updates. This is useful when the cycle counter is installed in an existing airframe or when an engine change is made.

The kit includes a serial programming cable, USB adapter cable and software CD with programming instructions. The programming kit allows for specific values to be changed associated with items 5, 8, 9 10 & 11 and can be password protected by the end user to prevent any un-authorized changes to be made.

ITEM 2 – Ng, Np speeds and Ng Max

The speed signals for Ng and Np are connected to the cycle counter microprocessor via individual 2 conductor, twisted and shielded wires. These wires are connected in parallel to the tachometer indicator signal wires behind the instrument panel.

Each signal wire is connected to separate channels on the microprocessor via opto-isolators. The analog speed signals from the engine are converted to a digital signal that is scaled to the same designed frequency as the tachometer generators on the engine.

When the aircraft is started the processor waits for a speed >= 30% Ng including an additional 5 second delay before the speed is considered as an actual engine start. This

filters out any spikes in the incoming Ng signal due to the low frequency at engine start. At this point Ng, Np are indicated, and the cycle counter is in operational state.

The frequency is continuously monitored for change in width and period of the sinewave and converted to microseconds by the processor. This process is a function of the pulse period and changes linearly as the speed changes.

The software conversion of the pulse period to the corresponding frequency is displayed on the first data screen as Ng and Np Speed in percentage (%) and is to one decimal place.

The resultant displayed speed corresponds directly with the tachometer indicator on the instrument panel + or – 0.5 % and provides the operator confirmation that the cycle counter is operating correctly. This is accomplished by observing and comparing the displayed cycle counter speeds with the tachometer indicators for both Ng and Np.

The "Max" Ng speed indication in RPM on the first data screen shown below the Np speed is the maximum Ng speed seen by the cycle counter between manual resets. It is useful for determination of the max K1 value accrued by the cycle counter "Flt" cycles.

Since the Ng and Np speed indications are in real time and match the tachometer indicators on the instrument panel, confirmation that the system is operational can be easily confirmed.

See the note in item 3 below for "reset" explanation.

ITEM 3 – Ng "Flt"

The "Flt" value on the top line corresponds to the Ng accumulated cycles between resets and is to the right of the Ng speed.

NOTE 1: A "reset" is accomplished by the red pushbutton on the side of the cycle counter and adds the accumulated "Flt" cycles to the totals on the second data screen. The daily Ng "Flt" values are then reset to zero for the next flight period when the reset button is pressed and released. It is recommended that the operator record the daily "Flt" values in the flight log at the end of each flight day prior to resetting the cycle counter for the next flight day. If the operator neglects to do this, any subsequent recorded flight cycles are added to the prior values.

The following process by which Ng cycles are accumulated is per the TM Linear interpolation methodology. Table 2 shows the basic overall count methodology for major and minor (partial) cycles whilst Table 2a & 2b shows how the linear process for the major count is applied through the increasing speed range in detail.

NOTE 2: Ng cycles are not recorded until the Ng speed is >= 91% at which point the A/C is light on the skids and is approaching flight. This prevents any cycles from being recorded during ground runs for maintenance purposes.

With Ref to Table 2 (K1 Chart) & Table 2a & 2b (K1 Linear Graph), at 91-93% Ng, a value of 0.500 is recorded and at 94.3% Ng is increased to a value of 0.565 then at 98.2% to a value of 0.820 Ng and so on up to a max value of 1.00 at 100% Ng. This value is the "one time" maximum K1 value between each start – flight – shutdown.

With Ref to Table 2 (K2 chart), the partial K2 Ng cycles are additional values added to K1 when the Ng speed has initially reached >= 91% on takeoff and from thereafter is < =85% then > 85% Ng. Depending on the speed reached < =85% these values are added to K1 when Ng becomes
> 85% without shutdown.

Table 2 (K2) Example - If the Ng speed decreases to 82% then increases > 85% then a value of 0.05 is added to K1. If the Ng speed decreases again to 79% then increases > 85% then a value of 0.10 is added to K1 and so on.

ITEM 4 – Np "Flt"

The "Flt" value on the second line corresponds to the Np accumulated cycles between resets and is to the right of the Np speed.

NOTE: A "reset" is accomplished by the red pushbutton on the side of the cycle counter and adds the accumulated "Flt" cycles to the totals on the second data screen. The daily Np "Flt" values are then reset to zero for the next flight period when the reset button is pressed and released. It is recommended that the operator record the daily "Flt" values in the flight log at the end of each flight day prior to resetting the cycle counter for the next flight day. If the operator neglects to do this, any subsequent recorded flight cycles are added to the prior values.

Following is the process by which Np cycles are accumulated and are shown as an example in Table 3.

Np cycles are not recorded until the Ng speed is >= 91% at which point the A/C is light on the skids and is approaching flight. This prevents any cycles from being recorded during ground runs for maintenance purposes.

When Ng >= 91% and Np >98%, a value of 1.0 is recorded for Np. This value is the "one time" maximum F1 value between each start – flight – shutdown.

The partial Np (F2) cycle is an additional value added to F1 when the Np speed has initially reached >98% and from thereafter is <= 85% then > 98% Np. Depending on the speed reached <= 85% there are four (4) grouped speed ranges that have values

associated with the speed range reached during the partial cycle event (see Table 3) . These values are added to the F1 value when Np then goes > 98% without shutdown.

Table 3 (F2) Example (Arriel 1D1) - If the Np speed decreases to 78% then increases > 98% then a value of 0.30 is added to F1. If the Np speed decreases again to 67% then increases >98% then a value of 0.5 is added to F1 and so on.

ITEM 5 – Engine starts

An engine start is recorded when the Ng speed is >= 91% Ng at which point the A/C is light on the skids and is approaching flight. This prevents any starts from being recorded during ground runs for maintenance purposes. It increments by a value of 1 between each start – flight – shutdown. This value does not reset when the reset button is pressed and continues to accumulate all engine starts.

ITEM 6 – Ng "Ops"

The Ng "Ops" (operations) counter corresponds to the Ng partial operations accumulated between resets. The counter increments by a value of 1 whenever an Ng partial cycle event is recorded as described by item 3.

NOTE: A "reset" is accomplished by the red pushbutton on the side of the cycle counter. The daily Ng "Ops" values are reset to zero for the next flight period when the reset button is pressed and released. It is recommended that the operator record the daily Ng "Ops" values in the flight log at the end of each flight day prior to resetting the cycle counter for the next flight day. If the operator neglects to do this, any subsequent recorded operations are added to the prior values.

ITEM 7 – Np "Ops"

The Np "Ops" (operations) counter corresponds to the Np partial operations accumulated between resets. The counter increments by a value of 1 whenever an Np partial cycle event is recorded as described by item 4.

NOTE: A "reset" is accomplished by the red pushbutton on the side of the cycle counter. The daily Np "Ops" values are reset to zero for the next flight period when the reset button is pressed and released. It is recommended that the operator record the daily Np "Ops" values in the flight log at the end of each flight day prior to resetting the cycle counter for the next flight day. If the operator neglects to do this, any subsequent recorded operations are added to the prior values.

ITEM 8 – Ng Total

When the "reset" button on the side of the cycle counter is pressed and released the accumulated Ng "Flt" cycles are added to the Ng Total which represents the accumulative Ng total for the engine.

ITEM 9 – Np Total

When the "reset" button on the side of the cycle counter is pressed and released the accumulated Np "Flt" cycles are added to the Np Total which represents the accumulative Np total for the engine.

ITEM 10 – Flight time

This is a timer representing flight time which is also used for determining maintenance intervals. It accumulates time in 0.1 hour (6 minute) increments.

The flight time starts to accumulate when the engine is running and the collective "UP" micro switch is made ie. A/C is approaching flight. The prior saved accumulated timer value and count down timer is loaded from non-volatile memory and continues the process of counting down from 360 seconds (6 minutes). When it reaches zero, the accumulative timer increments by a value 0.1 and the count-down timer starts again at 360 seconds. When the collective is full down and the collective micro switch is un-made ie. A/C has landed, the timer stops counting down and saves the accumulated and count-down timers until the collective is raised again and the process repeats.

Confirmation of the correct operation of the flight timer and collective up signal can be observed by noting the change from (OFF) to (ON) when the collective switch is made and from (ON) to (OFF) when the collective is full down and the switch is un-made.

NOTE: If the collective micro switch STC is not installed then alternate Cycle Counter software is available that controls the flight timer as follows:

When the Ng speed is >= 91% Ng at which point the A/C is light on the skids and is approaching flight. The prior saved accumulated timer value and count down timer is loaded from non volatile memory and continues the process of counting down from 360 seconds (6 minutes). When it reaches zero the accumulative timer increments by a value 0.1 and the count down timer starts again at 360 seconds. When Ng < 75% the timer stops counting down and saves the accumulated timer and count down timer until Ng >= 91% at which point they are reloaded and counting continues. The OFF/ON indication is not shown with this software version.

ITEM 11 – Run time

This is a timer representing engine run time. It accumulates time in 0.1 hour (6 minute) increments. Run time is controlled when the Ng speed is >= 30% Ng at which point the A/C engine is running. The prior saved accumulated timer value and count down timer is loaded from non-volatile memory and continues the process of counting down from 360 seconds (6 minutes). When it reaches zero, the accumulative timer increments by a value 0.1 and the countdown timer starts again at 360 seconds. When Ng < 30% the timer stops counting down and saves the accumulated timer and count down timer. When the engine started again and Ng >= 30% they are reloaded and counting continues.

Confirmation of the run timer operation can be observed by noting the change from (OFF) to (ON) when the engine is started and from (ON) to (OFF) when the engine is shutdown.

NOTE: With the alternate software installed (see Note under Item 10 – Flight Time) the OFF/ON indication is not shown with this software version.

End "ITEM" description

General information

All the accrued data is stored in non-volatile Eeprom memory and is accomplished on engine shut when the Ng speed <=30%.

When the red “reset” button is pressed, the newly updated Ng and Np totals are re-saved and the Ng and Np “Flt”, Ng Max and Ng and Np “Ops” will reset to zero. The black “screen” button changes the screens between the first and second data screen.

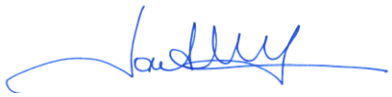
NOTE: With the collective interface installed, the cycle counter uses a single computer input for both the red “reset” button and the collective up signal functions. When the engine is running, the input controls the flight time with the collective up signal via our supplied external relay as part of the installed kit. When N1 is < 30% it reverts to a reset function. If the collective micro switch is out of adjustment and still producing a signal when the collective is down, then when N1 < 30% it immediately resets the counter. You might notice the second screen totals increasing in cycles with nothing showing on the first screen.

When running the engine and the collective is full down, check the Flight time on the second screen totals shows (OFF). Raise the collective and confirm it then shows (ON). If it does not, then the collective micro switch needs to be looked at.

All saved data is re-loaded from the non-volatile Eeprom when the engine starts and Ng >= 30% plus 5 seconds.

28V DC power is provided via a dedicated 2 conductor, twisted and shielded wire and via a 1-amp circuit breaker.

Author: Jonathan Gunn

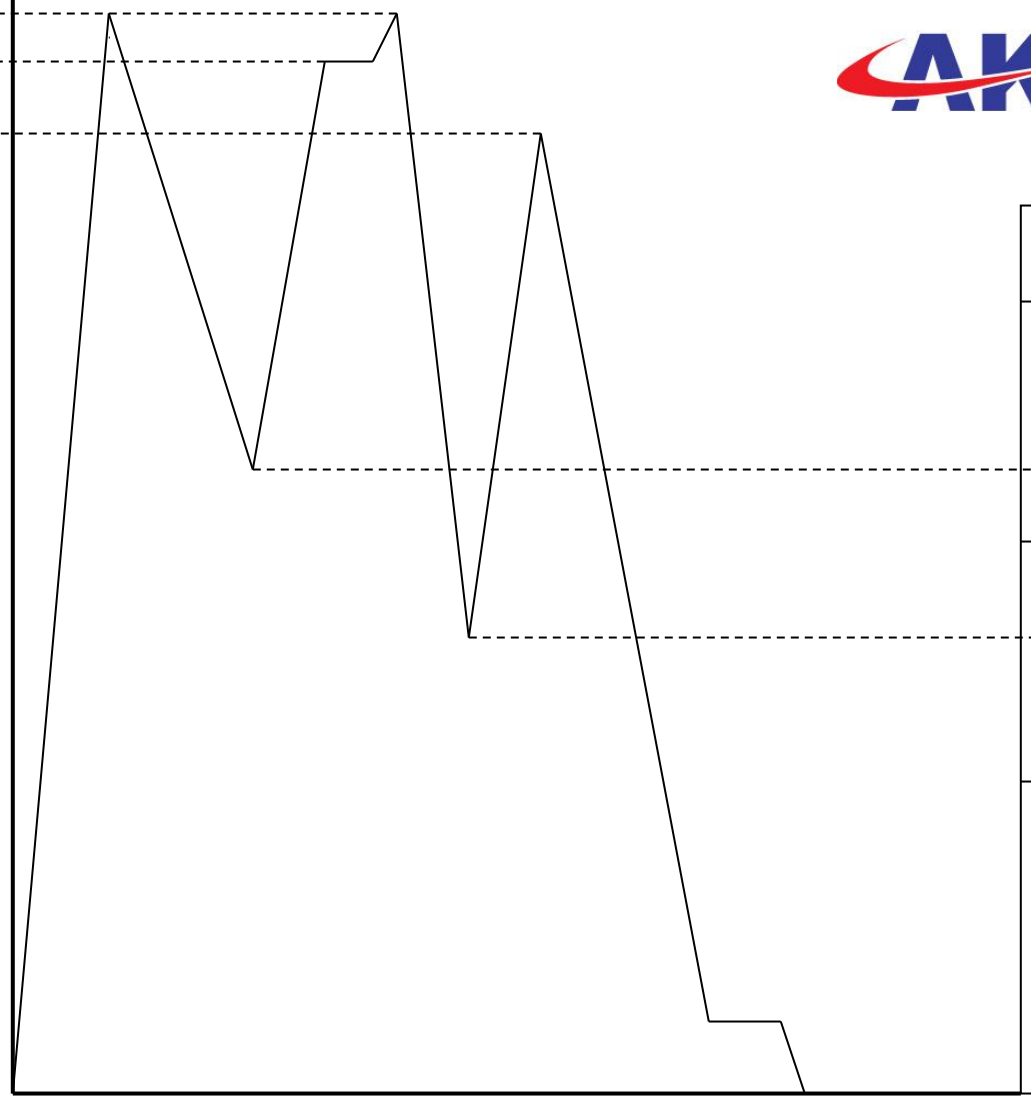


Engineering

Formula N = K1 + n. K2

N = 0.82 + n. 0.05 +0.10 = **0.97 Ng FLT Cycles**

Max Ng	K1
100	1.000
99	0.900
98.2**	0.820
97	0.700
96	0.650
94.3*	0.565
94.0	0.550
<=93	0.500



Min Ng	K2
<=85 84 83 82 81	0.05
<81 80 79 78 77 76	0.10
<76 75 74 73 72 71 70	0.15

For detailed K1 linear graph values
* See Table 2a
** See Table 2b

Table 2

Cycle Counter Ng example flight

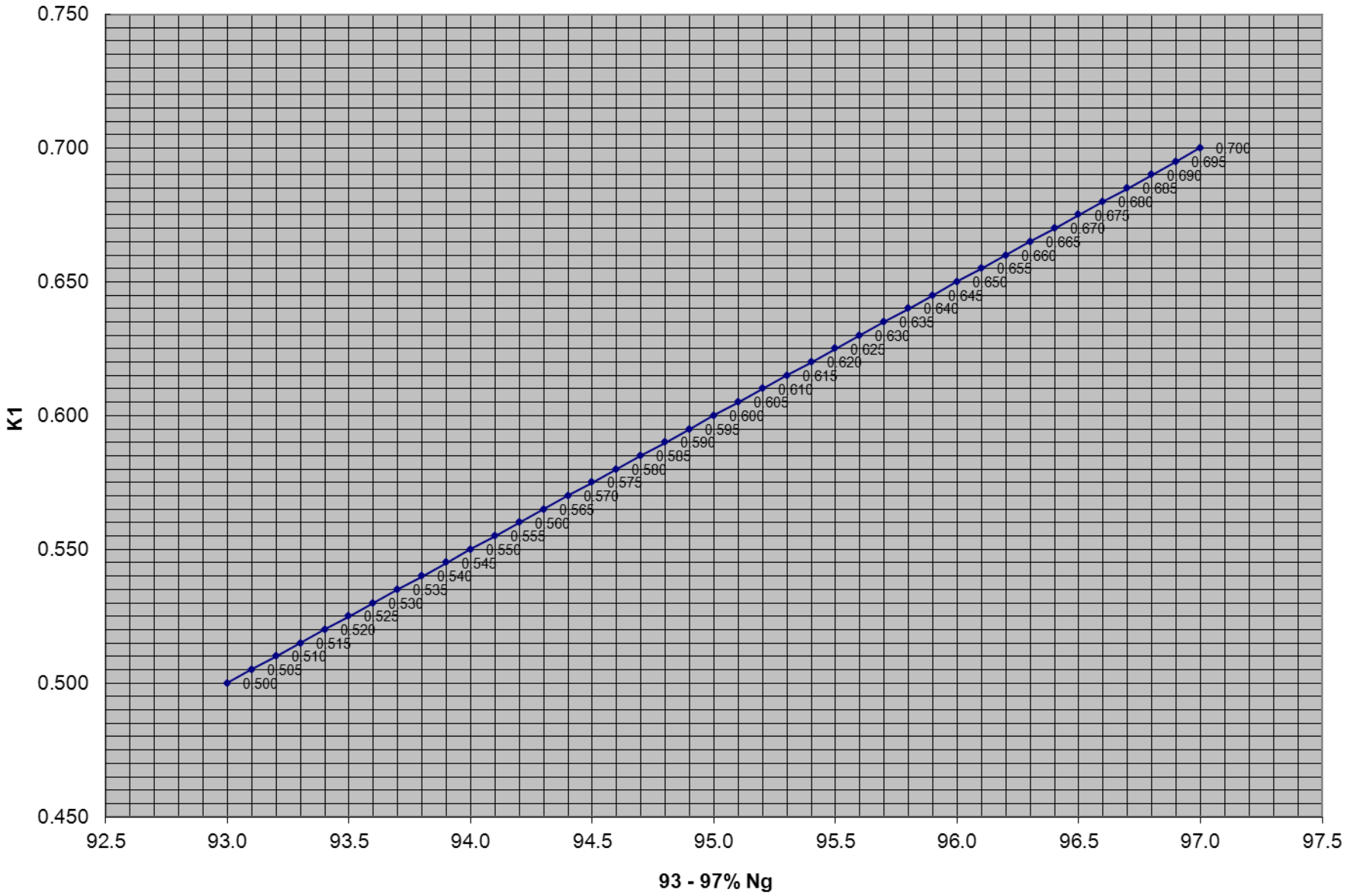


Table 2a

K1 detailed linear graph example range 93 – 97% Ng

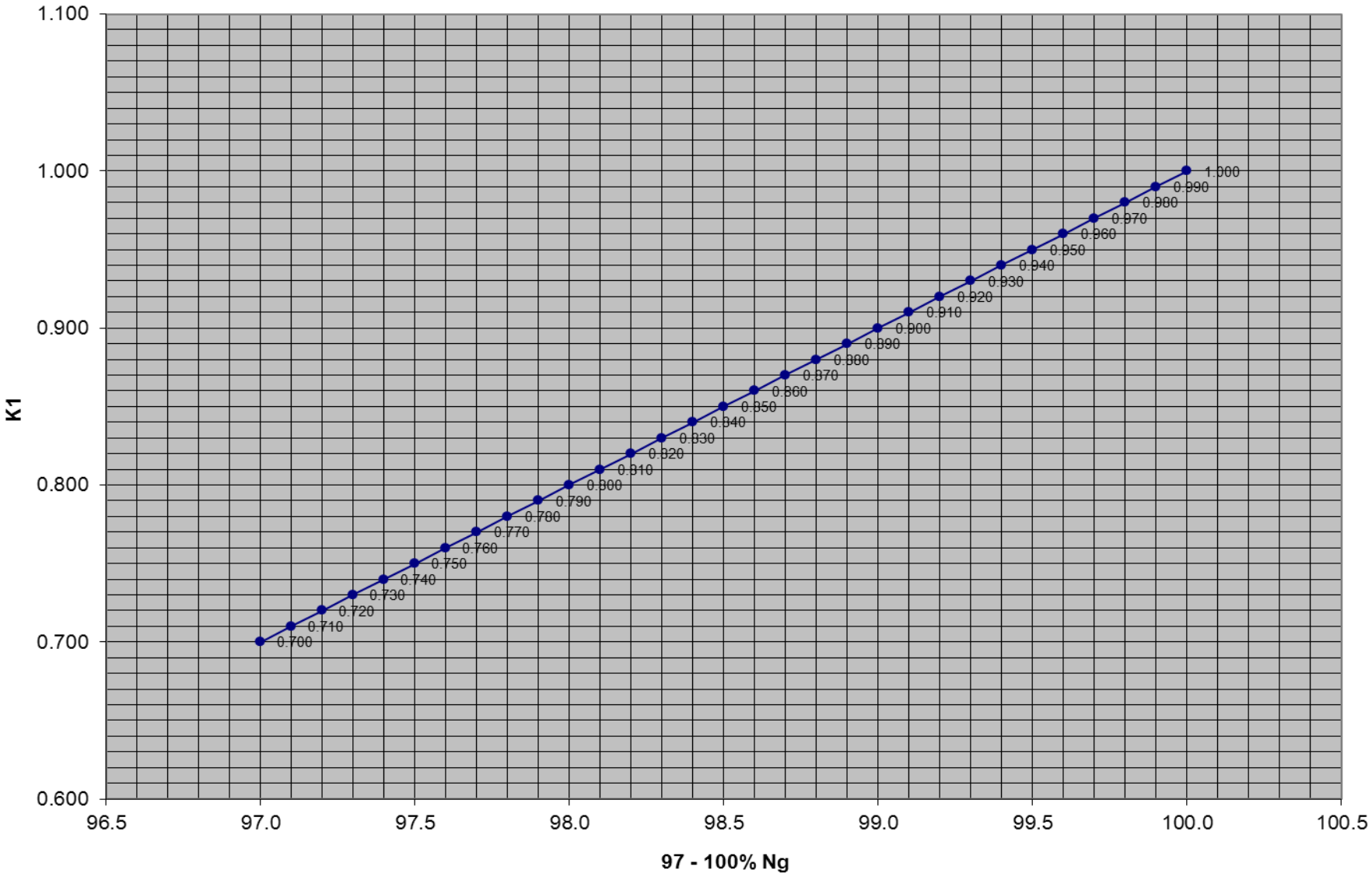


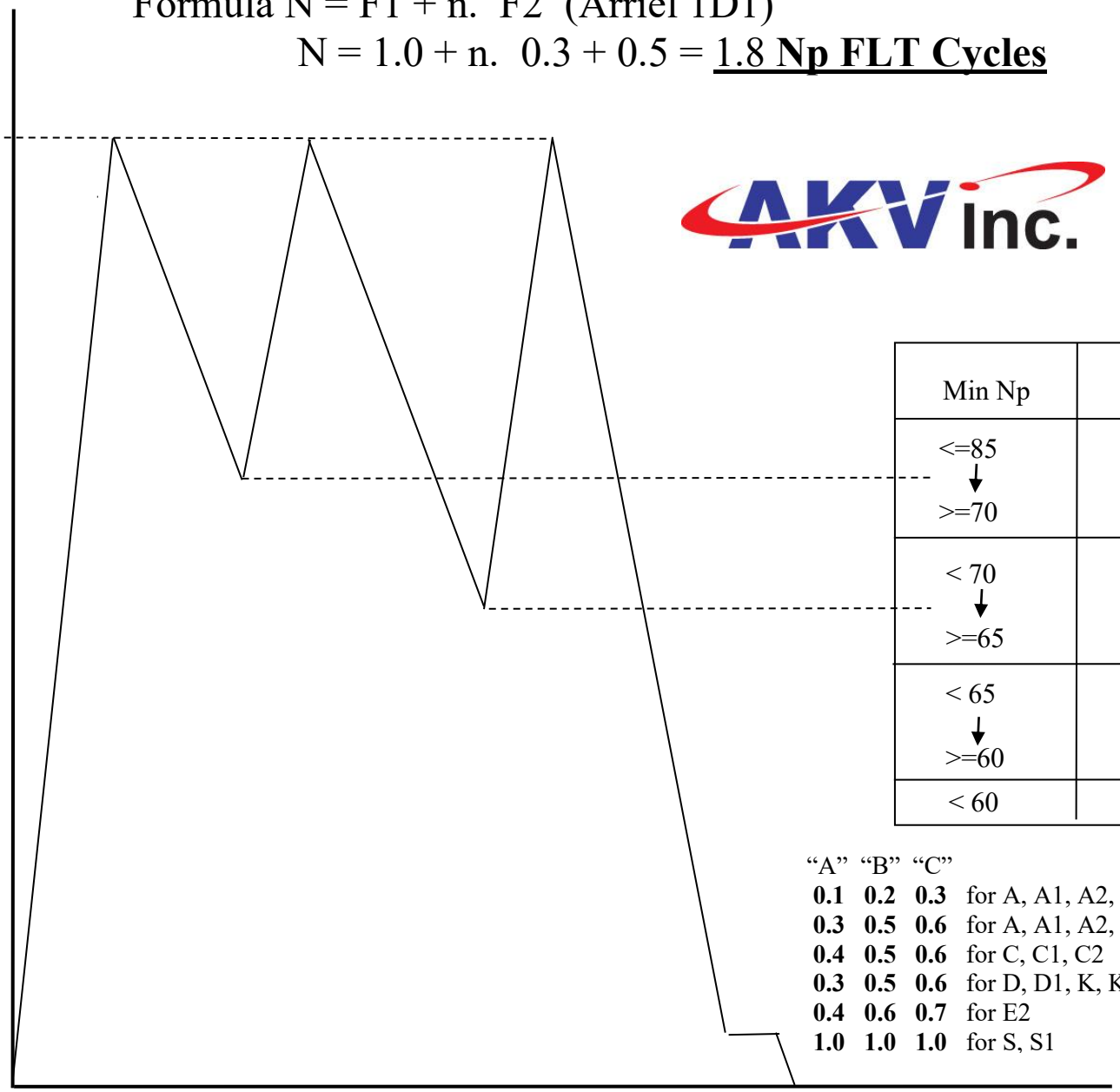
Table 2b

K1 detailed linear graph example range 97 – 100% Ng

Formula N = F1 + n. F2 (Arriel 1D1)

N = 1.0 + n. 0.3 + 0.5 = <u>1.8 **Np FLT Cycles**</u>

Max Np	F1
100 99 >98	1



Min Np	F2
<=85 ↓ >=70	See “A”
< 70 ↓ >=65	See “B”
< 65 ↓ >=60	See “C”
< 60	1.0

“A”	“B”	“C”	
0.1	**0.2**	**0.3**	for A, A1, A2, B (Pre TU77)
0.3	**0.5**	**0.6**	for A, A1, A2, B (Post TU77)
0.4	**0.5**	**0.6**	for C, C1, C2
0.3	**0.5**	**0.6**	for D, D1, K, K1
0.4	**0.6**	**0.7**	for E2
1.0	**1.0**	**1.0**	for S, S1

<u>Table 3</u>

Cycle Counter Np example Flight