INSTRUCTION MANUAL

BALANCE BUDDY

A Tool for Field Balancing

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PREFACE

PLEASE READ BEFORE USING MANUAL

DON'T let the number of pages in the Vitec, Inc. Balance Buddy instruction manual intimidate you! The manual was written in a detailed step-by-step format so that even a beginner can successfully balance field machinery.

Most chapters are broken into two sections. One section consists of COMPLETE PROCEDURES, including instructions on how to balance or collect the data. The second section contains ABBREVIATED INSTRUCTIONS, which list only the operation of the Balance Buddy. Most chapters include sample calculations so that you can practice with the Balance Buddy before having to use it in the field.

BASIC OPERATION OF THE BALANCE BUDDY

The Vitec, Inc. Balance Buddy is a computer programmed for vibration balancing and vibration conversions. There is no need for complicated procedures to start the unit. The operator need only do the following steps.

1. Turn the Balance Buddy "ON" with the power slide switch. (See Note 1)

2. Select the desired program by pressing the "S" key (think of it as a START key) then the proper program key, PO through P6.

The programs included with the Balance Buddy are:

PO - Single Plane Balancing
P1 - Single Plane Trim Balance
P2 - Weight Consolidation
P3 - Weight Splitting
P4 - Vibration Mode Conversions
P5 - Two Plane Balancing
P6 - First Shot Balancing

The Balance Buddy can also be used as a standard calculator by pressing the desired number keys after turning the unit on <u>without</u> pressing the "S" key. The (*) key represents multiplication, the (/) key represents division, and the "EXE" (Execute) key can be thought of as the equal (=) key.

NOTES: 1.) When the unit is turned on, the lower part of the display should show a blinking cursor. The upper half of the display should read, "CAPS", "CAL" and "DEG".

2.) The BRK key can be used as the Stop key to stop the execution of the program. The BS key can be used as the Back Space key to erase the last number entered.

3.) The Balance Buddy has a power-saving feature that shuts off the computer after about 6 minutes if it is not being used. Should this happen between balancing procedures, press the "BRK" key to restart the computer.

It is recommended that the unit be returned to Vitec, Inc. every two years for battery replacement.

SINGLE PLANE BALANCING (P0)
SINGLE PLANE TRIM BALANCING (P1)
COMPLETE INSTRUCTIONS

SINGLE PLANE BALANCING (P0)

SINGLE PLANE TRIM BALANCING (P1)

COMPLETE INSTRUCTIONS

Single plane balancing techniques can be employed on a machine with a relatively rigid shaft and a rotor radius that is greater than the rotor's length. In the past, machine balancing was a time consuming problem involving plotting of polar graphs, manual calculations or plain old trial and error. Vitec, Inc.'s Balance Buddy transforms this problem into a very simple procedure.

The balancing procedure requires that both vibration and phase readings be taken on the machine before and after a trial weight is added to the machine being balanced. As a matter of convention, phase measurements are to be read as positive (clockwise) angles.

1. A reference mark is used to read the phase of the vibration through the use of a strobe light. Scribe, paint or put a piece of tape on the end of the rotating shaft to serve as a vivid easy-to-read reference mark. Some method of measuring the phase angles will also be required. Using the Vitec, Inc. MARK-400 Strobe/Remote Phase Probe panel is the easiest method of determining the phase angle of vibration, since the phase angle is displayed on the MARK-400 Strobe/Remote Phase Probe panel. A sheet of polar graph paper with the center removed will sometimes slip over the rotating shaft providing an excellent gauge for reading the phase angle. A disc with degree marks on it that is slightly smaller than the rotating element is also a very handy tool to have. By holding it in front of the rotating element, an accurate phase reading can be obtained (attach the disc to a handle for safety). Any other method will suffice, but the more precise the measurement, the better the results.

2. Mount the vibration transducer on the machine and bring the machine up to its normal speed and load. Record the vibration and the phase reading of the reference mark. Stop the machine. Once the balancing procedure has begun, <u>do not</u> move the transducer. Movement of the transducer can cause errors in subsequent phase readings.

3. Mount a suitable trial weight (record the amount) on the machine and run it back up to its normal speed and load. Use care with variable speed machines. The speed for the second set of readings <u>must</u> be the same as for the first set of readings. Record the resultant vibration and phase readings.

4. Turn the Balance Buddy "ON", press the "S" key (think of it as the "start" key) followed by P0 (P0 refers to Program 0). Enter the appropriate values as prompted, pressing the "EXE" ("execute") key to input the values after each numerical entry. The locations and amount of the final balance weight is given in degrees from the position of the trial weight in a clockwise (CW) or counterclockwise (CCW) direction. The final balance weight is given in the same units of

weight as the units used for the trial weight. If a value of "1" was used for the trial weight, the final balance weight amount will be expressed as a ratio. For example, if the final balance weight reading was 1.59, a weight 1.59 times the trial weight should be used.

5. Mount the final balance weight on the machine (be sure to remove the trial weight) at the required location. Again run the machine up to its normal speed and load. Record the resultant vibration and phase. If the vibration reading is not yet acceptable, a "trim" balance will be necessary.

SINGLE PLANE TRIM BALANCE (P1)

6. To perform a "trim" balance, turn the Balance Buddy "ON" and press shift "S" followed by P1 (Program 1). Enter the recorded values as prompted. A new location and possibly a new weight will be displayed. The new trim balance location given is measured from the final balance weight position. If the amount of weight is different from the balance weight, adjust the balance weight accordingly. BE CAREFUL - if the original trial weight was entered in (ounces, pounds, grams, etc.), then the trim balance program will list the trim balance weight in the units entered (ounces, pounds, grams, etc.). If the trial weight was entered as "1", the trim balance weight will be expressed as a ratio of the ORIGINAL TRIAL weight used, not the FINAL BALANCE weight.

If the vibration level has not decreased to an acceptable level, several "trim" balances can be run to reduce the vibration even further. CAUTION should be used however! MOST BALANCING CAN BE ACCOMPLISHED WITH ONLY ONE OR TWO TRIM BALANCE ATTEMPTS. If the vibration does not decrease significantly in one or two balance runs, problems other than just imbalance may exist in the machine. STOP attempting to balance the machine. Check to see that you are performing the balance calculations correctly. Check for other machinery problems such as misalignment, looseness, broken mounts, etc.

SINGLE PLANE BALANCING (P0)
SINGLE PLANE TRIM BALANCING (P1)
ABBREVIATED INSTRUCTIONS

SINGLE PLANE BALANCING PROCEDURE (P0)

SINGLE PLANE TRIM BALANCING PROCEDURE (P1)

ABBREVIATED INSTRUCTIONS

1. Turn Balance Buddy "ON".

2. Press "S" (think of it as "start"), then P0 (Program 0).

3. Enter the original vibration, "ORIG VIB?", press "EXE".

4. Enter the original phase, "PHASE?", press "EXE".

5. Enter the trial weight value. "TRIAL WGT?", press "EXE". Use the weight in pounds, ounces, grams, etc. If the actual weight is not known, use a value of "1", and the final balance weight required will be expressed as a proportion of the trial weight (e.g.: a calculated final balance weight of 1.59 would mean 1.59 times the original trial weight used).

6. Enter the resultant vibration, "RES VIB?", press "EXE".

7. Enter the resultant phase, "PHASE?", press "EXE".

8. Read the amount of final balance weight needed "BAL WGT __.__", press "EXE".

9. Read the location of the final balance weight expressed as degrees clockwise (CW) or degrees counterclockwise (CCW) from the trial weight, "at __.__ degrees CW or CCW". Remember to remove the trial weight.

10. If a trim balance if required, press "S", then P1 (Program 1).

11. Enter the new vibration level after the final balance weight was added to the machine "RES VIB?", press "EXE".

12. Enter the new phase angle after the final balance weight was added to the machine "PHASE?", press "EXE".

13. Read the amount of weight to be used to trim balance the machine "BAL WGT __.__", press "EXE".

14. Read the location of the trim balance weight as degrees clockwise (CW) or degrees counterclockwise (CCW) from the final balance weight position "at __.__ degrees CW or CCW".

SINGLE PLANE BALANCING (P0)

SINGLE PLANE TRIM BALANCING (P1)

SAMPLE CALCULATIONS

Familiarize yourself with the operation of the computer. Practice with these problems before trying to balance a machine in the field.

Sample Single Plane Calculations

SAMPLE #1: (P0)

ORIG VIB	3.0 mils
ORIG PHASE	70 degrees
TRIAL WGT	2.5 ounces
RES VIB	5.0 mils
RES PHASE	25 degrees

FINAL BAL WGT = 2.10 ounces at 98.61 degrees clockwise (CW)

TRIM BALANCE: (P1)

RES VIB	2.0 mils
RES PHASE	10 degrees

BAL WGT = 2.38 ounces at 40.89 degrees clockwise (CW)

SAMPLE #2: (P0)

ORIG VIB	10 mils
ORIG PHASE	90 degrees
TRIAL WGT	1 ounce
RES VIB	5 mils
RES PHASE	95 degrees

BAL WGT = 1.98 ounces at 4.96 degrees counterclockwise (CCW)

TRIM BALANCE: (P1)

RES VIB	2.0 mils
RES PHASE	100 degrees

BAL WGT = 2.47 ounces at 2.48 degrees counterclockwise (CCW)

TWO PLANE BALANCING (P5)
COMPLETE INSTRUCTIONS

TWO PLANE BALANCING (P5)

COMPLETE INSTRUCTIONS

Two plane balancing techniques can be employed on a machine with a relatively rigid shaft and a rotor radius that is less than the rotor's length.

Balancing a machine in two planes is a little more involved than balancing in a single plane. Balance weights must be determined for both ends of the element to be balanced. To discover the appropriate weights and their locations, trial balance runs must be made by attaching test weights at each end of the machine and recording the resultant changes in imbalance. Vibration and phase readings are required for both ends of the machine initially, and each time a trial weight is added. The Vitec, Inc. Balance Buddy simplifies this procedure greatly by assuming the burden of all required calculations.

In the instructions that follow, the near end (N) refers to the end of the machine where phase is to be measured. The far end (F) refers to the opposite end. ALL PHASE MEASUREMENTS ARE TO BE TAKEN AT ONE END OF THE MACHINE (N) and be read as positive angles (clockwise).

For the greatest ease in taking vibration and phase measurements, it is recommended that a vibration transducer be mounted at each end of the machine to be balanced. In this manner, measurements can be taken without the need to remove and remount a transducer each time a measurement is required. The Vitec, Inc. MARK-400 Strobe/Remote Phase Probe panel will provide the capability to carry out both vibration and phase readings, without the need to remove the transducers.

Once the following balance procedure has begun, do not move the transducers. If two transducers are not available, extra care must be exercised to guarantee that the transducer is always remounted in exactly the same location at each end of the machine. Also be careful with variable speed machines. All readings for the entire balancing procedure must be taken at the same speed and load.

1. A reference mark is used to read the phase of the vibration through the use of a strobe light. Scribe, paint or put a piece of tape on both ends of the shaft of the rotating element. Both reference marks should point in exactly the same direction. Some method of measuring the phase angles will also be required. Using the Vitec, Inc. MARK-400 Strobe/Remote Phase Probe panel is the easiest method of determining the phase angle of vibration, since the phase angle is displayed on the MARK-400 Strobe/Remote Phase Probe panel. A sheet of polar graph paper with the center removed will sometimes slip over the rotating shaft providing an excellent gauge for reading the phase angle. A disc (with degree marks on it) that is slightly smaller than the rotating element's shaft is also a very handy tool to have. By holding it in front of the rotating shaft, an accurate phase reading can be obtained (attach the disc to a handle for safety). Any other method will suffice, but the more precise the measurement, the better the results.

2. With the machine running at normal speed and under normal load, record the vibration (VIB,N) and phase (PHASE,N) using the near end (N) transducer. Record the vibration (VIB,F) and phase (PHASE,F) using the far end (F) transducer. NOTE: Even though the FAR END (F) transducer is used, the actual phase reading is taken on the NEAR END (N).

3. After stopping the machine, attach a trial weight to the near (N) end at the same radius the finished balance weight is to be mounted. Record the amount of weight used, (WGT,N) and the position of the weight (WGT,N degrees). The position of the weight is recorded as degrees from the REFERENCE mark, and always as a positive angle. To make things simpler, it may be easiest to place the weight on the reference mark, and record the angle as 0 degrees.

4. Run the machine back up to its normal operating speed and load. Record the vibration (VIB,N1) and phase (PHASE,N1) using the near (N) transducer. Record the vibration (VIB,F1) and phase (PHASE,F1) using the far (F) transducer.

5. Stop the machine and remove the near (N) trial weight. BE SURE TO MARK WHERE THE TRIAL WEIGHT WAS PLACED BEFORE REMOVING IT FROM THE MACHINE! THE PLACEMENT OF THE FINAL BALANCE WEIGHT WILL BE EXPRESSED IN DEGREES CLOCKWISE OR COUNTERCLOCKWISE FROM THE POSITION OF THE TRIAL WEIGHT.

6. Attach a trial weight to the far (F) end. Record the weight (WGT,F) and its location (WGT,F degrees). IMPORTANT: The location of the far (F) trial weight must be measured from the point of view of the near (N) end. As an example: When looking head on at the (F) end, a measurement of twenty degrees clockwise locates the same point as 340 degrees clockwise when looking head on at the (N) end. The Balance Buddy expects to see this measurement as 340 degrees. Again after bringing the machine up to normal speed and load, record the vibration (VIB,N2) and phase (PHASE,N2) using the (N) transducer. Record the vibration (VIB,F2) and phase (PHASE,F2) using the (F) transducer. REMEMBER: All phase readings are taken from the NEAR (N) end.

7. Stop the machine and remove the (F) trial weight. Again, be sure to mark where the trial weight was placed. This point will serve as a reference point for placement of the final balance weight.

8. Turn the Balance Buddy "ON" and press shift (the "S" key) followed by P5 (P5 refers to Program 5). The display will ask whether this is a "trim" balance. Press the "-" key to tell the Balance Buddy this is not a "trim" balance. Prompts will then be displayed for entry of the values recorded during the balance procedure. At each prompt, enter the appropriate value. The amplitude of the vibration is always requested first, followed by its associated phase.

After the last value is entered, approximately six seconds will pass before the near (N) correction weight (WNc) is displayed. Pressing the "EXE" button will display the correction angle. The far (F) correction (WFc) can be displayed by again pressing the "EXE" button. One more push of the "EXE" key will display (F) correction angle.

9. Mount the correction weights on the machine using the angles specified. NOTE: You need not adjust the far end angle to the point of view of the (N) end for weight placement! The Balance Buddy has already compensated for this. The angles displayed for each end are correct as displayed. The locations of the final balance weights are given as degrees [in either a clockwise (CW) or counterclockwise (CCW) direction] from the position of the TRIAL weight on the appropriate end of the machine. The final balance weight is given in the same units of weight as the units used for the trial weight. If a value of "1" was used for the trial weight, the final balance weight amount will be expressed as a ratio. For example, if the final balance weight reading was 1.59, a weight 1.59 times the trial weight should be used. Correction weights must be attached at the same radius as the trial weights. Be sure the trial weights have been removed from the machine.

   Those well versed in balancing procedures will realize that correction weights can be mounted at any radius if the amount of weight is adjusted for the given radius. Since the Balance Buddy assumes no units when it requests the magnitudes of trial weights, these values can be entered as forces (such as ounce inches or gram centimeters) instead of weights. The values then displayed will be in terms of the units entered. If this technique is employed, it will be up to the individual to calculate the correct weight and radius to be used. Example: If a weight of 10 grams is located at a radius of 20 centimeters, it will generate the same force as a weight of 16 grams located at a radius of 12.5 centimeters. (10 X 20 = 16 X 12.5)

10. After running the machine back up to operating speed, record the vibration (VIB,N) and phase (PHASE,N) using the (N) transducer. Record the vibration (VIB,F) and phase (PHASE,F) using the (F) transducer. Remember that phase readings are recorded as viewed from the near end of the machine. If the vibration levels are not yet satisfactory, a trim balance will be required.

    If the Balance Buddy is still on (it turns itself off after a few minutes of non-use), press the "EXE" to bring up the "TRIM BAL?" prompt. Press the "+" key to select the trim balance routine. If the Balance Buddy has been switched off, turn it on and press Shift "S" followed by P5. If the Balance Buddy has turned itself off, press the "AC" key, then "S", and P5 to bring back the "TRIM BAL?" prompt. Even though the Balance Buddy may have been turned off, the values recorded during the balance procedure remain in memory. It is these values that permit a successful "Trim" balance to be run. Under no circumstances should any other procedure be run before the trim balance is run. Were this to occur, the values recorded from the balance procedure would be destroyed since all Balance Buddy programs share a common memory. The only way to recover from this mishap would be to re-enter all sixteen values and then press the "EXE" key (4 times) until the "Trim" prompt again appears.

11. After selecting a trim balance, enter the (N) and (F) values just recorded. Upon entry of the 4th value, new correction weights and angles will be displayed. These corrections are to be mounted in the same manner as the originals. The locations of the "Trim" weights are given in degrees (CW or CCW) from the appropriate trial weight's location. The original corrections are not to be disturbed.

    If the vibration level has not decreased to an acceptable level, several "Trim" balances can be run to reduce the vibration even further. CAUTION should be used however! MOST BALANCING CAN BE ACCOMPLISHED WITH ONLY ONE OR TWO TRIM BALANCE ATTEMPTS. If the vibration does not decrease significantly in one or two balance runs, problems other than just imbalance may exist in the machine. Stop attempting to balance the machine. Check to see that you are performing the balance calculations correctly. Check for other machinery problems such as misalignment, looseness, broken mounts, etc.

TWO PLANE BALANCING (P5)
ABBREVIATED INSTRUCTIONS

TWO PLANE BALANCING PROCEDURES (P5)

ABBREVIATED INSTRUCTIONS

Turn the Balance Buddy "ON", press the "S" key (think of it as "start"), then press P5 (Program 5). At the "Trim" prompt, press the "-" key to select a complete balance procedure.

1. Enter the original near end (N) vibration (VIB,N), press "EXE".
2. Enter the original (N) phase (PHASE,N), press "EXE".
3. Enter the original far end (F) vibration (VIB,F), press "EXE".
4. Enter the original (F) phase (PHASE,F), press "EXE".
5. Enter the resultant (N1) vibration (VIB,N1), press "EXE". The 1 represents the 1st trial run with a trial weight on the near end.
6. Enter the resultant (N1) phase (PHASE,N1), press "EXE".
7. Enter the resultant (F1) vibration (VIB,F1), press "EXE".
8. Enter the resultant (F1) phase (PHASE,F1), press "EXE".
9. Enter the resultant (N2) vibration (VIB,N2), press "EXE". The 2 represents the 2nd trial run with a trial weight on the far end.
10. Enter the resultant (N2) phase (PHASE,N2), press "EXE".
11. Enter the resultant (F2) vibration (VIB,F2), press "EXE".
12. Enter the resultant (F2) phase (PHASE,F2), press "EXE".
13. Enter the amount of the (N) trial weight (WGT,N), press "EXE".
14. Enter the location of the (N) trial weight (WGT,N degrees), press "EXE".
15. Enter the amount of the (F) trial weight (WGT,F), press "EXE".
16. Enter the location of the (F) trial weight (WGT,F degrees), press "EXE".
17. Read the amount of weight (WNc) required to balance the near end of the machine, press "EXE".
18. Read the location of the weight required to balance the near end of the machine, press "EXE".
19. Read the amount of weight (WFc) required to balance the far end of the machine, press "EXE".

20. Read the location of the weight required to balance the far end of the machine, press "EXE".

    If a trim balance is required, turn the Balance Buddy "ON", press "S", followed by P5. At the "Trim" prompt, press the "+" key to select a trim balance. The values from the original balance runs must still be in the Balance Buddy's memory in order to run a trim balance.

21. Enter the resultant (N) vibration (VIB,N), press "EXE".

22. Enter the resultant (N) phase (PHASE,N), press "EXE".

23. Enter the resultant (F) vibration (VIB,F), press "EXE".

24. Enter the resultant (F) phase (PHASE,F), press "EXE".

25. Read the amount of weight (WNc) required to trim balance the near end of the machine, press "EXE".

26. Read the location of the weight required to trim balance the near end of the machine, press "EXE".

27. Read the amount of weight (WFc) required to trim balance the far end of the machine, press "EXE".

28. Read the location of the weight required to trim balance the far end of the machine.

SAMPLE CALCULATIONS

TWO PLANE BALANCING (P5)

Familiarize yourself with the operation of the computer. Practice with these problems before trying to balance a machine in the field.

Sample Two Plane Calculations

SAMPLE #1:

VIB,N	5.5 mils
PHASE,N	78 degrees
VIB,F	9.9 mils
PHASE,F	42 degrees
VIB,N1	0.2 mils
PHASE,N1	132 degrees
VIB,F1	1.9 mils
PHASE,F1	114 degrees
VIB,N2	1.5 mils
PHASE,N2	246 degrees
VIB,F2	1.1 mils
PHASE,F2	204 degrees
WGT,N	1
WGT,N degrees	0.0 degrees
WGT,F	1
WGT,F degrees	0.0 degrees

WNc = .68 times the (N) trial weight at 302.56 degrees CW from (N) trial weight.

WFc = .66 times the (F) trial weight at 38.57 degrees CCW from (F) trial weight.

SAMPLE CALCULATIONS

TWO PLANE BALANCING (P5)

SAMPLE #2:

VIB,N	2.1 mils
PHASE,N	20 degrees
VIB,F	3.3 mils
PHASE,F	330 degrees
VIB,N1	2.3 mils
PHASE,N1	70 degrees
VIB,F1	5.2 mils
PHASE,F1	320 degrees
VIB,N2	1.9 mils
PHASE,N2	100 degrees
VIB,F2	2.7 mils
PHASE,F2	0.0 degrees
WGT,N	3.5 ounces
WGT,N degrees	0.0 degrees
WGT,F	3.5 ounces
WGT,F degrees	0.0 degrees

WNc = 2.35 ounces at 129.27 degrees CW from (N) trial weight.

WFc = 4.5 ounces at 39.18 degrees CW from (F) trial weight.

Trim Balance:

VIB,N	1.1 mils
PHASE,N	117 degrees
VIB,F	0.8 mils
PHASE,F	323 degrees

WNc = 1.34 ounces at 179.46 degrees CCW from (N) trial weight.

WFc = .58 ounces at 123.29 degrees CW from (F) trial weight.

SAMPLE CALCULATIONS

TWO PLANE BALANCING (P5)

SAMPLE #3:

VIB,N	7.4 mils
PHASE,N	270 degrees
VIB,F	5.6 mils
PHASE,F	270 degrees
VIB,N1	4.8 mils
PHASE,N1	210 degrees
VIB,F1	4.0 mils
PHASE,F1	210 degrees
VIB,N2	9.3 mils
PHASE,N2	180 degrees
VIB,F2	9.0 mils
PHASE,F2	180 degrees
WGT,N	18 ounces
WGT,N degrees	0.0 degrees
WGT,F	18 ounces
WGT,F degrees	0.0 degrees

WNc = 26.31 ounces at 22.71 degrees CW from (N) trial weight.

WFc = 4.93 ounces at 187.29 degrees CW from (F) trial weight.

SAMPLE CALCULATIONS

TWO PLANE BALANCING (P5)

SAMPLE #4:

VIB,N	10 mils
PHASE,N	90 degrees
VIB,F	10 mils
PHASE,F	90 degrees
VIB,N1	5 mils
PHASE,N1	95 degrees
VIB,F1	10 mils
PHASE,F1	90 degrees
VIB,N2	10 mils
PHASE,N2	90 degrees
VIB,F2	5 mils
PHASE,F2	95 degrees
WGT,N	1 ounce
WGT,N degrees	0.0 degrees
WGT,F	1 ounce
WGT,F degrees	0.0 degrees

WNc = 1.98 ounces at 4.96 degrees CW from (N) trial weight.

WFc = 1.98 ounces at 4.96 degrees CW from (F) trial weight.

The above is a single plane problem solved with the Two Plane program.
Use the (WNc) values for balancing.

WEIGHT SPLITTING (P3)

COMPLETE INSTRUCTIONS

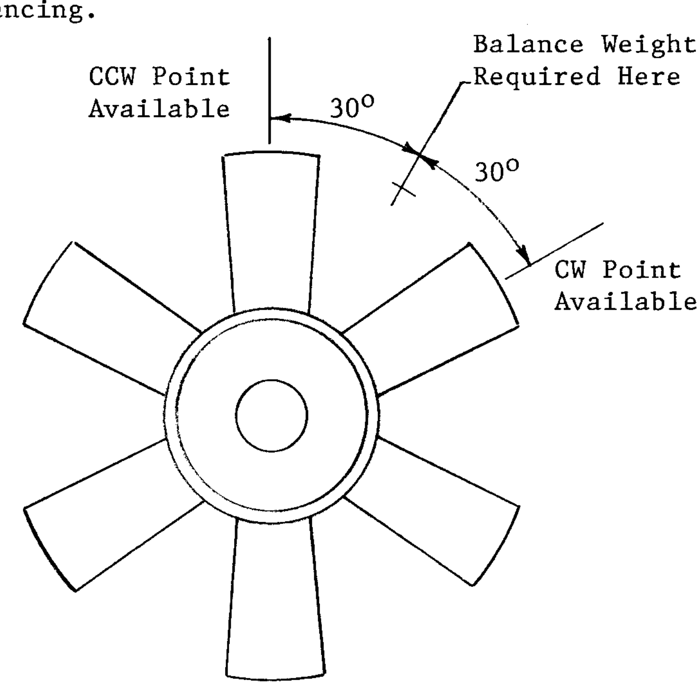
The results of balancing procedures may indicate that weight be added or removed from the rotating member. In some cases it may be physically impossible to attach or remove weights at the indicated positions. For example, the balancing calculations for a fan may indicate that weight be added at a point that is actually between two blades.

Weight splitting is a procedure used to locate two weights in alternate positions that will equal the required balance weight at the specified location. The two weights combined will have the same effect on the machine as if one weight were positioned at the point specified.

CAUTION should be used as to when to employ weight splitting. The combined weight of the two weights used will always total more than the weight of the single balance weight required. The machine may be brought into balance with the two weights, but the weight of the rotor may have been increased significantly. The increased weight of the rotor may reduce the savings associated with balancing.

A typical application for weight splitting would be a fan that needs a balance weight placed somewhere between two blades. Weight splitting will allow the operator to determine how much weight should be placed on each of the blades to equal the final balance weight required (see Fig. 1).

When a final balance weight cannot be mounted at the indicated position, select two viable alternate points. One point should be "CCW" from the required position, the other should be "CW" from the required position.



Turn the Balance Buddy "ON", press shift "S" followed by P3 (Program 3). Enter the initial weight, press "EXE". Enter the "CCW" angle (measured from the initial point), press "EXE". Enter the "CW" angle (measured from the initial point), press "EXE". The new "CCW" weight will be displayed.

Pressing "EXE" again will cause the new "CW" to be displayed. If the sum of the two angles is greater than 180 degrees, negative values will be displayed. Negative values indicate that weight is to be removed rather than added. This procedure assumes that all weights are to be mounted at the same radius.

NOTE: Both angles should be entered as positive numbers even though they indicate opposite directions. If an error message is displayed instead of an answer, then it is physically impossible to offset the initial weight with weights located at the requested angles.

WEIGHT SPLITTING (P3)
ABBREVIATED INSTRUCTIONS

WEIGHT SPLITTING (P3)

ABBREVIATED INSTRUCTIONS

1. Turn Balance Buddy "ON".

2. Press "S", then P3 (Program 3).

3. Enter the initial weight required to balance the machine, "INIT WGT?", press "EXE".

4. Enter the Counterclockwise (CCW) angle between the point where weight is required to the point where weight can be applied, "CCW degrees?", press "EXE".

5. Enter the Clockwise (CW) angle between the point where weight is required to the point where weight can be applied, "CW degrees?", press "EXE".

6. Read the weight to be applied to the Counterclockwise location, "CCW WGT __.__", press "EXE".

7. Read the weight to be applied to the Clockwise location, "CW WGT __.__".

SAMPLE CALCULATIONS

WEIGHT SPLITTING (P3)

SAMPLE #1:

Calculated final weight 10.0 ounces
Counterclockwise (CCW) location available, 10 degrees
Clockwise (CW) location available, 20 degrees

RESULTS:

CCW weight 6.84 ounces
CW weight 3.47 ounces

SAMPLE #2:

Calculated final weight 10.0 ounces
Counterclockwise (CCW) location available, 15 degrees
Clockwise (CW) location available, 30 degrees

RESULTS:

CCW weight 7.07 ounces
CW weight 3.66 ounces

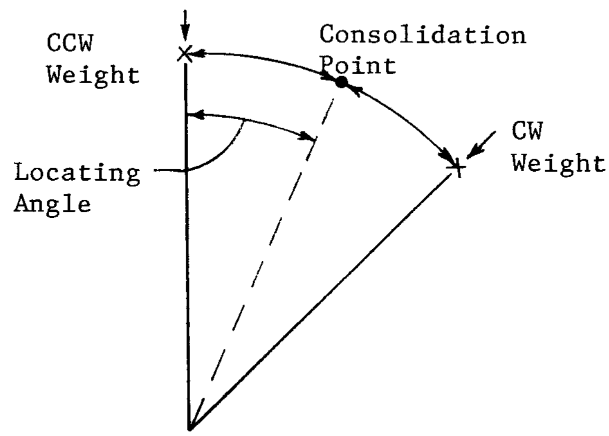
WEIGHT CONSOLIDATION (P2)
COMPLETE INSTRUCTIONS

WEIGHT CONSOLIDATION (P2)

COMPLETE INSTRUCTIONS

Weight consolidation is a procedure whereby two weights are replaced by a single weight that provides the same effect as the two combined original weights.

Turn the Balance Buddy "ON" and press shift "S", followed by P2 (Program 2). Enter the Counterclockwise (CCW) weight, press "EXE". Enter the Clockwise (CW) weight, press "EXE". Enter the "angle" between the two weights and then press "EXE". The Balance Buddy will display the magnitude of the weight giving the same effect as the two original weights. Pressing "EXE" again will display where the weight must be located relative to the original Counterclockwise "CCW" weight's locations. This procedure assumes that all weights are to be mounted at the same radius.



If it is desired to consolidate more than two weights, they will have to be considered two at a time. Choose two weights and consolidate them. Then use the resultant weight as one of the next two weights to be consolidated. Continue in this manner until all weights are consolidated into one, or stop when weights are in desired configuration.

WEIGHT CONSOLIDATION (P2)

ABBREVIATED INSTRUCTIONS

1. Turn Balance Buddy "ON".

2. Press "S", then P2 (Program 2).

3. Enter the Counterclockwise (CCW) weight, "CCW WGT?", press "EXE".

4. Enter the Clockwise (CW) weight, "CW WGT?", press "EXE".

5. Enter the angle in degrees between the CCW and CW positions, "ANGLE", press "EXE".

6. Read the amount of weight required to consolidate the CW and CCW weight, "WGT = __.__", press "EXE".

7. Read the angle between the Counterclockwise (CCW) position and the location of the new consolidated weight position, "at __.__ degrees CW".

SAMPLE CALCULATIONS

WEIGHT CONSOLIDATION (P2)

SAMPLE #1:

CCW WEIGHT	6.84 ounces
CW WEIGHT	3.47 ounces
ANGLE BETWEEN	30 degrees

RESULTS:

WEIGHT = 10.00 at ... 9.99 degrees CW from CCW weight

SAMPLE #2:

CCW WEIGHT	7.07 ounces
CW WEIGHT	3.66 ounces
ANGLE BETWEEN	45 degrees

RESULTS:

WEIGHT = 10.00 at ... 15.00 degrees CW from CCW weight

FIRST SHOT BALANCING (P6)
COMPLETE INSTRUCTIONS

FIRST SHOT BALANCING (P6)

COMPLETE INSTRUCTIONS

First Shot Balancing is a unique procedure employing past vibration readings to provide better results on the first attempt (first shot) at balancing a machine. This procedure can also be useful for machines used to balance rotating parts in assembly line situations.

First Shot balancing uses past balancing data to determine the sensitivity of both the machine being balanced and the sensitivity of the instrumentation being used for balancing. Since First Shot balance uses past data for some of its calculations, it cannot be used the very first time a machine is balanced.

The information needed for "First Shot" is the point on the machine where imbalance occurs (relative to the vibration transducer) and the amount of the imbalance. The "imbalance point" is determined by the initial phase reading of the unbalanced machine and the location of the finished balance weight. The amount of any future imbalance is derived from the initial imbalance vibration, the finish balance vibration, the amount of weight used to balance the machine and the vibration due to any subsequent imbalance. This all sounds very complicated, but the Balance Buddy does all the required calculations.

1. Using the Balance Buddy, balance the machine while recording all values measured. "Trim" balance the machine (if necessary) to achieve the best possible balance. It is important to achieve the best possible balance since the "First Shot" technique strives to restore the original balance. At best, "First Shot" can only restore the system to the original state of balance.

2. Once the machine is balanced, rotate its shaft until the reference mark is in the exact position recorded as the final phase angle of the unbalanced machine. Note the position of the finished balance weight. The imbalance point (the heavy spot) for this machine will be exactly 180 degrees opposite the finished balance weight. If you normally add weight to balance the machine, fix a permanent pointer on the machine housing at the location of the finished balance weight (Balance weight point). If weight is normally removed to achieve balance, fix the pointer at the location of the imbalance point (opposite the balance weight). Fixing pointers at both locations will permit you to easily choose whether you want to add or remove weight to achieve a balanced condition.

3. On future balancing runs, bring the machine up to its normal running speed and record the vibration and phase reading. After the machine is stopped, simply rotate the shaft until the reference mark is in the same location as the phase reading just taken. The "heavy spot" on the machine will be at the location of the imbalance point pointer.

4. Now that the point of imbalance has been determined, all that is needed is the balance weight. Turn on the Balance Buddy. Press

shift "S" followed by P6. Enter the original vibration of the unbalanced machine; press "EXE". Enter the original weight used to balance the machine; press "EXE". Enter the original finished balance vibration; press "EXE". Enter the vibration value just taken and press "EXE". The new balance weight will be displayed.

5. Mount the new balance weight next to the "Balance weight point" or, if preferred, remove the same amount of weight at the "Imbalance point".

The "Imbalance point" established remains constant for any given machine as long as the test procedure remains constant. The machine should always be run at the same speed and load. The same analyzer and transducer as well as the transducer's location should also remain the same. However, the actual part being balanced on the machine need not remain the same.

In an assembly line situation, it may be necessary to balance many similar mass produced parts. Record player turntables are one such instance. The machine used to test spin the turntables would be balanced first. The first turntable could then be mounted on the machine and again a complete balance procedure would be performed. The values recorded in the second balance run would establish the "Imbalance point" for the turntables. Each successive turntable could then be balanced with the "First Shot" technique.

FIRST SHOT BALANCING (P6)

ABBREVIATED INSTRUCTIONS

1. Switch the Balance Buddy "ON".
2. Press "S, then P6 (Program 6).
3. Enter the original vibration (ORIG,VIB?), press "EXE".
4. Enter the balance weight (BAL,WGT?), press "EXE".
5. Enter the balance vibration (BAL,VIB?), press "EXE".
6. Enter the resultant vibration (RES,VIB?), press "EXE".
7. Read the weight to applied (BAL WGT __.__).

SAMPLE CALCULATIONS

FIRST SHOT BALANCING (P6)

SAMPLE #1:

ORIGINAL VIBRATION	1.00 mils
BALANCE WEIGHT	2.00 ounces
BALANCE VIBRATION	3.00 mils
RESULTANT VIBRATION	4.00 mils
BALANCE WEIGHT	5.00 ounces

SAMPLE #2:

ORIGINAL VIBRATION	2.00 mils
BALANCE WEIGHT	3.00 ounces
BALANCE VIBRATION	4.00 mils
RESULTANT VIBRATION	5.00 mils
BALANCE WEIGHT	3.50 ounces

CONVERSIONS (P4)

Tired of dragging out paper, pencils, calculators or nomographs to convert from one vibration measurement mode to another? With Vitec Inc.'s Balance Buddy, these are tools of the past! The six conversions most frequently used for vibration analysis are now just a few keystrokes away. Whether your frequency readings are in Cycles per Minute (CPM) or Cycles per Second (Hz), the Balance Buddy will instantly convert: displacement to velocity or acceleration, velocity to acceleration or displacement and acceleration to displacement or velocity.

To calculate a conversion, switch on the Balance Buddy and press the shift "S" key followed by P4. There is a separate prompt for each conversion. If the prompt displayed is the conversion you want to perform, simply press the (+) key to proceed. If some other conversion is desired, press the (-) key and the next type of conversion will be displayed. The (+) key always selects the displayed conversion, the (-) key skips to the next conversion. Having selected a particular conversion, enter the values as prompted pressing the "EXE" key to enter the value. Upon entry of the last value, the answer will be displayed. Pressing the "EXE" once more will allow another conversion.

The Balance Buddy always prompts for frequency as CPM. If your readings are in Hertz, simply enter a zero for CPM and you will be prompted for a Hertz value. If a mistake is made while keying in a value, press the "AC" key to clear the display and type the correct value. The conversion program can be stopped at any time by pressing the stop key.

SAMPLE CALCULATIONS

VIBRATION MODE CONVERSIONS (P4)

DISPLACEMENT TO VELOCITY:

mils displacement	2
CPM	3600

Velocity = 0.3770 in/sec

VELOCITY TO ACCELERATION:

in/sec velocity	.378
CPM	3600

Acceleration = 0.3680 Gs

ACCELERATION TO DISPLACEMENT

Gs acceleration	.368
CPM	0
Hertz	60

Displacement = 2.0044 mils

DISPLACEMENT TO ACCELERATION:

mils displacement	2
CPM	0
Hz	60

Velocity = 0.3673 Gs

VELOCITY TO DISPLACEMENT:

in/sec velocity	.378
CPM	0
Hertz	60

Displacement = 2.0055 mils

ACCELERATION TO VELOCITY:

Gs acceleration	.368
CPM	3600

Velocity = .3778 in/sec

MATH USED IN BALANCING

OUNCE INCHES

Weight in ounces X radius in inches
Example:
8 oz. X 5 inches = 40 ounce inches

FINAL WEIGHT vs. TEST WEIGHT

Test weight of 8 oz. at 5 inches
New radius is 10 inches. What weight (W) is required?
8 X 5 = 10 X W
W = 4 ounces

CENTRIFUGAL FORCE FORMULA

Force in pounds
$F = 1.776 \times 10^{-6} \times \text{oz. in.} \times RPM^2$
EXAMPLE:
$F = 1.776 \times 10^{-6} \times 40 \text{ oz. in.} \times 1{,}000^2$
F = 71 pounds
For 2,000 RPM
F = 284 pounds

BALANCE TOLERANCE PRECISION

Oz. in. = 4W/RPM where W is weight in pounds
EXAMPLE: 900 pound part, operating at 1800 RPM
Oz. in. = 4 X 900/1800
Oz. in. = 2 oz. in.

CHECKLIST - FOR POSSIBLE CAUSES OF

CHANGE IN FAN OR BLOWER BALANCE

1. DIRT - Buildup of dirt on blades, backplate or shroud. Dirt may buildup unevenly, or flake off randomly causing imbalance.

2. PAINT - Paint or coating on blades may flake off randomly.

3. WEAR - Fans handling abrasive material may wear unevenly.

4. HEAT WARPAGE - The first time hot gases are passed through a new installation, the fan wheel may assume a new geometric shape due to warpage. Older installations may encounter warpage through a sudden heat increase.

5. MATERIAL INSIDE A HOLLOW BLADE - A fan may change balance if water, dirt or other contaminants enter a hollow blade through pinholes in the blade or welds on the blade.

6. UNDERSIZE SHAFT - The rotational or spin center of a shaft may be affected by a shaft worn undersize at the bearing fit.

7. HUB LOOSE ON BACKPLATE - Riveted hubs sometimes loosen. Welding around the hub or replacing the rivets with bolts have made successful repairs.

8. STRESS RELIEF DUE TO CENTRIFUGAL FORCES - High speed fans sometimes change shape when first installed due to stress relieving.

9. FAN HUB LOOSE ON SHAFT

10. LOST BALANCE WEIGHT - Some manufacturers use small clips for balancing that can be lost during operation of the unit or cleaning of the unit.

TWO PLANE BALANCING DATA SHEET

DATA SHEET

TWO PLANE BALANCING

MACHINE DATA BELOW, USE BACK OF PAGE FOR MACHINE SKETCH.

MACHINE ID# ______________________ DATE __________

______________________________ BY __________

RPM / LOAD DATA ______________________________

WEIGHT OF ROTOR __________ RADIUS OF WEIGHT __________

1. ORIG. VIB. NEAR (VIB, N)	______	ORIG. PHASE NEAR (PHASE, N)	______
2. ORIG. VIB. FAR (VIB, F)	______	ORIG. PHASE FAR (PHASE, F)	______
3. RES. VIB. NEAR (VIB, N1)	______	RES. PHASE NEAR (PHASE, N1)	______
4. RES. VIB. FAR (VIB, F1)	______	RES. PHASE FAR (PHASE, F1)	______
5. RES. VIB NEAR (VIB, N2)	______	RES. PHASE NEAR (PHASE, N2)	______
6. RES. VIB FAR (VIB, F2)	______	RES. PHASE FAR (PHASE, F2)	______
7. NEAR TRIAL WGT AMOUNT (WGT, N)	______	LOCATION (WGT, N degrees)	______
8. FAR TRIAL WGT AMOUNT (WGT, F)	______	LOCATION (WGT, F degrees)	______
9. NEAR WGT TO BALANCE (WNc)	______	LOCATION (degrees)	______
10. FAR WGT TO BALANCE (WFc)	______	LOCATION (degrees)	______
------------- TRIM BALANCE -------------			
11. NEW VIB NEAR (VIB, N)	______	NEW PHASE NEAR (PHASE, N)	______
12. NEW VIB FAR (VIB, F)	______	NEW PHASE FAR (PHASE, F)	______
13. NEAR TRIM WGT TO BAL.	______	TRIM LOCATION NEAR	______
14. FAR TRIM WGT TO BAL.	______	TRIM LOCATION FAR	______

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