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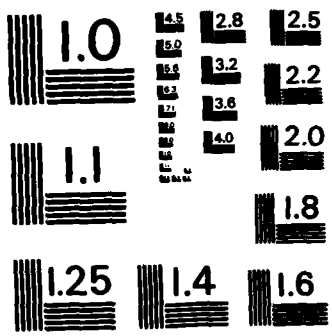

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BLENDING STICK PROPELLANT

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US ARMY ARMAMENT MUNITIONS & CHEMICAL COMMAND
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US ARMY ARMAMENT RESEARCH AND DEVELOPMENT CENTER
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Development of an artillery propelling charge containing stick propellant created the need for a new blending process. Early propellant lots produced for product improvement testing demonstrated poor uniformity, but further analysis indicated the propellant was not adequately blended. This report analyzes the blending procedure used during production of the propellant lots that resulted in poor uniformity and illustrates the poor distribution of the stick propellant. A proposed blending procedure is also described which theoretically demonstrates an acceptable distribution of the propellant sticks.

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INTRODUCTION

The introduction of stick propellant into artillery propelling charges created the need for a new blending process. Stick propellant (29 inches long) cannot be handled with the same equipment as granular propellant (approximately 1 inch long) without getting broken or bent. The procedure developed for blending stick propellant packed in boxes was modified and applied to new production of M203E2 propelling charges while the propellant was still in cabinets. The propellant lots produced demonstrated poor uniformity during the stick propellant wear test at Aberdeen Proving Ground (APG), Maryland. During this test, 360 firings of samples taken at the different blending stages were performed. Analysis of the performance at each blending stage revealed that the modified blending stages had no effect on uniformity of the propellant lots.[1] This conclusion, although valid for these samples, was not supported by previous data which showed a significant improvement in uniformity with subsequent blending.

Subsequently, a third procedure was proposed which should, theoretically, produce an acceptable blend.

DISCUSSION

Original Production

The original production of stick propellant for the M203E2 propelling charge product improvement program (PIP) at ARDC exhibited good ballistic uniformity. These lots, however, were small in quantity and, therefore, had few within-lot variations in the physical and chemical properties of the propellant. With the production of larger propellant lots (30,000 pounds) to support the U.S. Army Test and Evaluation Command (TECOM) product improvement tests (PIT), the velocity uniformity was poor at best. From the first two lots produced, three ballistic samples were tested at ARDC: two were selected at random from the two lots and the third was a blended sample from the second lot. The random samples yielded standard deviations in velocity of 17.6 and 14.4 fps. The blended sample had an acceptable uniformity of 5.2 fps. To confirm that the poor uniformity was due to the propellant and not to other charge components, the three samples were retested without the combustible case. The two random samples, again, demonstrated poor uniformity with 13.6 and 14.8 fps, while the blended lot showed good uniformity of 5.4 fps. Both lots were subsequently blended at Radford AAP and tested. Ballistic test data (table 1) show acceptable uniformity after blending.

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[1] Eric R. Bixon and James J. Rutkowski, "Blending Study of M203E2 Stick Propellant," Technical Report ARPAD-TR-85002, ARDC, Dover, NJ (in press).

Modified PIP Production

Three propellant lots (RAD-PE-738-1A, -B, -1C) were produced using a modified blending procedure developed by Radford AAP for blending stick propellant during manufacture. These lots were sampled after each blending phase with four samples taken from each lot. Thirty propelling charges were assembled from each sample and fired in the M203E2 wear test at APG. Samples were identified with the following suffixes after the lot number: -1 represents samples taken after the first blending phase; -2 after the second, -3 after the third, and no suffix represents samples from the finished propellant lot. Final lot samples were randomly selected while -1, -2, and -3 samples were from the first two cabinets. Data are presented in tables 2 through 5. Note the unacceptable uniformity levels for the 1A, 1B, and 1C lot samples. Statistical analysis showed no difference between blending phases.[2]

While the study was being conducted, an additional lot of propellant (RAD-PE-663-7) consisting of 4,618 pounds was produced and tested at ARDC, with inconsistent ballistic results (lower charge weight gave higher ballistics). A uniformity series was fired and produced a standard deviation in velocity of 22.2 fps. When investigation indicated that the lot may never have been blended, it was returned to Radford for blending. Subsequent testing of the reblended lot at ARDC resulted in acceptable levels of 8.1, 5.3, 7.9, 7.9, 8.5, 4.6, 5.1, and 6.3 fps (5-round groups).

Results

There are three possible explanations for the results obtained from the 360 rounds fired during the blending study:

1. Blending has no effect on uniformity. This theory is improbable since the reblended lots (480-9A, 480-98B, and 663-7) showed significant improvement in uniformity.

2. Sampling was not strictly random; therefore, each blend phase was not properly represented. Since the sampling was not randomly selected, the results were probably influenced by the sampling. A nonrandom sample of lot 738-1A fired at ARDC showed a significant difference from those used in the blending study, but nonrandom samples of lots 738-1B and 738-C did not. The influence of the nonrandom sampling, however, was not great enough to explain the results obtained.

3. The propellant lots did not reach an adequate level of blending. This is considered the most likely explanation. If an adequate level of blending was not reached, there would be little or no difference between samples regardless of when they were selected. A detailed review of the modified blending

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[2] See footnote 1, page 1.

procedure used for these lots (738-1A, -1B, -1C) showed the level of blending achieved did not approach the original method.

Confirmation Test

To further confirm that propellant lots RAD-PE-738-1A, -1B, and -1C were not adequately blended, ten boxes of RAD-PE-738-1C propellant were selected out of 40 at ARDC. The box numbers ranged from the 200's to the 600's. The two lowest, the two highest, and six intermediate boxes were selected and segregated into two groups, each containing one box of the lowest and highest numbers and three intermediate numbers. From one group, two propelling charges were manufactured from each box.

The other five boxes were opened and then blended to produce a thoroughly mixed sample of 300 pounds. Ten charges were manufactured from this mixture, and both 10-round groups were fired at ARDC. The as-received sample produced a pressure standard deviation of 545 psi and a velocity standard deviation of 8.02 fps. The sample that was mixed at ARDC produced a standard deviation of 305 psi and a velocity standard deviation of 4.95 fps. These data support the conclusion that the present blending procedure for blending stick propellant during manufacture is inadequate.

BLENDING PROCEDURES

Blending Procedure (Lots 738-1A, 1B, 1C)

The modified blending and sampling procedure developed by Radford is described below. The discussion assumes a lot size of 72 cabinets each containing 18 trays of propellant, with no sampling at blending phases.

- Blend 1. From the cutting operation, there are 1,296 trays divided into four subgroups of 18 cabinets each (tables 6-9). The propellant in the low numbered trays is from the front of the drying bays and the high numbers are from the rear. For example, trays 1 to 10 are in the front, trays 500-800 are in the middle, and trays 1,286 to 1,296 are in the rear. This represents the blend 1 sample.

- Blend 2. Five cabinets each are removed from subgroups 1 and 2, and four cabinets each from subgroups 3 and 4 to create a new subgroup of 18 cabinets which are taken to another area with 18 empty cabinets numbered 1A through 18A.[3]

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[3] Assume the first cabinets are selected for simplicity in understanding this procedure; the actual procedure is first in-last out, whereas the same cabinets would be selected together anyway.

Cabinet 1 is then distributed to cabinets 1A through 18A by taking tray 1, placing it in cabinet 1A, tray 2 into cabinet 2A, tray 3 into cabinet 3A, etc. Cabinet 2 is also distributed by taking tray 19 and placing it in cabinet 1A, tray 20 into cabinet 2A, etc. All cabinets 1 through 5 (subgroup 1), 19 through 23 (subgroup 2), 37 through 40 (subgroup 3), and 55 through 58 (subgroup 4) are transferred to cabinets 1A through 18A as shown above. The result is illustrated in table 10. (This corresponds to completion of step 3 of the modified procedure.) This is repeated until all 72 cabinets are transferred to cabinets 1A through 72A.

The next step is to take each cabinet, one at a time, into a work room to blend and sort the propellant. Blending 2 or 3 trays at a time on the table creates a mixture in each tray of 50/50 or 33/33/33 of original trays See table 11 for an illustration of the first four cabinets after this step, assuming they were blended two trays at a time. Tray numbers correspond to original numbers shown in tables 6 through 9. This is the end of the blend 2 and corresponds to completion of step 6 of the modified procedure.

- Blend 3. The cabinets are divided into four subgroups: A1, A2, A3, and A4. Again, as in blend 2, cabinets are selected from each subgroup. Cabinets 1A through 5A from subgroup A1, cabinets 19A through 23A from subgroups A2, cabinets 37A through 40A from subgroup A3, and cabinets 55A through 58A from subgroup A4. The selected cabinets are taken to an area with 18 empty cabinets marked 1B through 18B. The top tray from cabinet 1A is placed in the top position of cabinet 1B, and the second tray from cabinet 1A is placed in position 10 of cabinet 1B. The first and second trays from cabinet 2A are placed in cabinet 1B directly under the trays from 1A, i.e., positions 2 and 11, respectively. The top two trays from cabinet 3A go into positions 3 and 12. The top two trays from the A cabinets fill cabinets 1B and 2B. The third and fourth trays of the A cabinets fill cabinets 3B and 4B. The procedure is continued until the four subgroups of A cabinets are transferred to four subgroups of B cabinets. The result is illustrated in table 12 by the first four B cabinets. This is the middle of blend 3 which corresponds to step 18 of the modified procedure. The transfer from A cabinets to B cabinets did not progress the blending since all the trays in cabinet 1B are from the original subgroup 1 and could be in sequential orders as shown in table 12. This step could be improved by a more random selection of cabinets across all subgroups; for example, cabinets 1A, 63A, 30A, 46A, etc., are selected at step 16. The end result, however, may still not be significant enough to warrant the manpower needed to transfer the trays.

The next step involves some blending within cabinets. Two trays (top and bottom) are removed from a cabinet and blended together to form two new trays. Each of the new trays contains approximately 1/4 of an original tray (100 sticks); for example, the top tray of cabinet 1B contains about 100 sticks each from original trays 1, 19, 94, and 112. See table 13 for examples of B cabinets after step 22 of the procedure. The procedure of mixing the top and bottom trays continues until all cabinets are completed. This is the end of blend 3.

- Blend 4. Two cabinets are taken from each subgroup of B cabinets. These eight B cabinets are taken to a work area with eight empty cabinets labeled 1C through 8C. Similar to the blend 3 procedure, the top trays of the B cabinets are transferred to slots 1 through 8 of the 1C cabinets, respectively. The next to the top (second) tray is placed in slots 9 through 16, respectively. The third trays are placed in slots 1 through 8 of the 2C cabinets and the fourth trays into 9 through 16 of the 2C cabinets. This procedure is continued until all trays are transferred to C cabinets. The first and last cabinet of the C group is illustrated in table 14 which corresponds to step 33 of the procedure. One cabinet from each subgroup of C cabinets is taken to the packout area. The top and bottom trays of each cabinet are removed and the propellant (about 200 pounds) is placed on a table and blended, then boxed (three boxes plus about 20 pounds remaining). The top and bottom trays are again removed from each cabinet, added to the 20 pounds remaining on the table, and blended. Again, three boxes of propellant are packed. The next eight trays plus the 40 remaining pounds fill up four boxes. The procedure is continued until the entire lot is packed in boxes. An illustration of how many of the original 1,296 trays are represented in a box of propellant is given in table 15. Each propellant box contains 60 pounds of propellant (approximately 960 sticks); therefore, about 30 sticks out of each of 32 of the original 1,296 trays are in each box. This is not considered an adequate blend and, in fact, this level of blending can be accomplished by simply randomly selecting 32 trays from blend 1 and putting about 30 sticks from each tray in a box, eliminating about 75% of the manpower necessary to blend to this level.

In the example in table 15, the trays represented are between 1 and 647, which covers only the front half of the dry houses. It is known that significant differences can exist between the front and back of dry houses.

Because of the limited blending of the original trays and the possible segregation of areas of the drying bays, the blending showed no significant improvement.

Proposed Blending Procedure

The proposed blending procedure is given below. The significant features of this procedure are:

1. Use of same facilities as previous blending procedures

2. No change to blend 1 procedure

3. More uniform blending during blend 2 procedure

4. Elimination of blend 3 procedure

5. Drastic reduction of blend 4 procedure

6. Easily increased to accommodate 8 subgroups (144 cabinets) or approximately 146,000-pound lots (further increase would probably require additional blending steps or handling and sampling modifications)

7. Can be initiated as soon as first 18 cabinets are filled from the cutting operation rather than having to wait until the entire lot is cut.

The new procedure is accomplished as follows:

- Blend A. No change to present blending procedure (step 1)

- Blend B. Instead of placing trays[4] from cabinet 1 into slot 1 of cabinets A1 to A18, each top tray receives 1/18th of each tray in cabinet 1. Therefore, all top trays in cabinets 1A through 18A contain the same mixture of trays 1 through 18. Each second tray of the A cabinets also contains a mixture of trays 19 through 36, and the third tray contains a mixture of 37 through 54, etc. All 18 cabinets of the first subgroup contain the same mixture of propellant on each tray (table 16). At this point, there is no difference between any cabinet in this subgroup. The procedure is repeated for the remaining subgroups; cabinets 19 through 36, 37 through 54, and 55 through 72 become 19A through 36A, 37A through 54A, and 55A through 72A, respectively.

Each tray is then hand mixed to eliminate layering.

The next step is to homogenize each cabinet. This can be easily accomplished during the blend and sort procedure. Instead of removing two full trays from the cabinet as in the modified procedure, approximately 1/9 of each tray (40 to 50 sticks) is placed on the tables, blended and sorted, then placed on empty trays in a new cabinet with the "A" suffix changed to "B". This procedure is continued until all cabinets are transferred to B cabinets (table 17). The original subgroups are maintained, i.e., subgroup 1 (cabinets 1 through 18) is transferred to subgroup A1 (cabinets 1A through 18A) and finally to subgroup B1 (cabinets 1B through 18B). This is accomplished with one less step (blend 3) than the modified procedure. Theoretically, every tray in a subgroup contains the same mixture of propellant; i.e., every tray in subgroup B1 contains a mixture of all the trays of the original subgroup 1 (324 trays).

- Packout. One cabinet from each subgroup is brought to the packing area, and one tray from each cabinet is placed on the table and blended. From this blend, boxes are packed. Theoretically, there should be 1 to 2 sticks from each of 700 to 900 of the original trays, a significant improvement over the modified method which results in about 30 sticks from each of 32 original trays.[5]

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[4] Although the term "tray" is used in the procedure, it should be considered a generic term for a container or box of any acceptable material that can be manufactured or procured economically. Cabinets may not be necessary when using boxes as self-stacking trays.

[5] The advantages of the proposed blending procedure are listed in table 18.

CONCLUSIONS

1. The original blending procedure for boxed stick propellant is acceptable (lots RAD-PE-480-98A, -480-98B, -480-98C, and 663-7).

2. The modified blending procedure for blending stick propellant in cabinets during manufacture is unacceptable (lots RAD-PE-738-1A, -1B, and -1C).

3. The proposed blending procedure for blending stick propellant during manufacture is acceptable based on theoretical analysis. The advantages are:

- One tray from each subgroup yields a blend containing one to two sticks from each of the original trays from the cutting operation.

- Each subgroup could be processed onto "B" cabinets without regard to the status of another subgroup; for example, subgroup 1 could be on "B" cabinets while subgroup 2 is still being cut to length.

- Procedure is easily expanded to eight subgroups or a 146,000-pound lot. Further expansion could be accomplished but may require an additional step in procedure.

- Every packed box of approximately 960 sticks should contain samples from about 720 original trays from the cutting operation.

- Elimination of an entire blending phase of the present procedure.

RECOMMENDATIONS

The proposed blending procedure can be implemented for future production of M31A1E1 stick propellant for the M203E2 propelling charge.

Table 1. Propellant lot uniformity at 70°F

	Lot RAD-PE-480-98A (fps)	480-98B (fps)	480-98C[b] (fps)
Assessment	17.6	14.4	5.2
Without combustible case	13.6	14.8	5.4
After blending[a]	7.7	4.5	—
		4.2	
	5.0	1.2	
	6.5	2.6	
		5.4	
		2.1	
		8.9[c]	
		9.5[c]	
		8.4[c]	
		4.9	
		2.9	
		6.4	
		2.1	
		8.5	

[a] After blending data (except 4.5 fps of 480-98B) was obtained during safety test and tube wear test at APG.

[b] Lot RAD-PE-480-98C is blended propellant from lot RAD-PE-480-98B.

[c] After humidity cycles.

Table 2. M203E2 propelling charge blending study IND 84E-738-1A

Lot no.	Round no.	Date	No. rounds	Muzzle velocity	Velocity standard deviation
1A	40-49	2 Aug 84	10	2,709	14.2
1A	315-324	9 Aug 84	10	2,713	10.9
1A	591-600	17 Aug 84	10	2,706	13.9
1A-1	50-59	2 Aug 84	10	2,704	4.2
1A-1	325-334	9 Aug 84	10	2,709	5.1
1A-1	601-610	17 Aug 84	10	2,700	5.[illegible]
1A-2	60-69	2 Aug 84	10	2,711	8.8
1A-2	335-344	9 Aug 84	10	2,707	8.8
1A-2	611-620	17 Aug 84	10	2,707	8.0
1A-3	70-79	3 Aug 84	10	2,712	11.0
1A-3	345-354	9 Aug 84	10	2,706	7.1
1A-3	621-630	17 Aug 84	10	2,695	5.6

Table 3. M203E2 propelling charge blending study IND 84E-738-1B

Lot no.	Round no.	Date	No. rounds	Muzzle velocity	Velocity standard deviation
1B	80-89	3 Aug 84	10	2,701	8.6
1B	355-364	9 Aug 84	9	2,694	11.2
1B	631-640	17 Aug 84	10	2,695	13.4
1B-1	90-99	3 Aug 84	10	2,713	14.9
1B-1	365-374	9 Aug 84	10	2,702	8.4
1B-1	641-650	17 Aug 84	10	2,696	12.2
1B-2	100-109	3 Aug 84	10	2,709	10.8
1B-2	375-384	9 Aug 84	10	2,697	7.1
1B-2	651-660	17 Aug 84	10	2,689	7.2
1B-3	110-119	3 Aug 84	10	2,699	8.8
1B-3	385-394	9 Aug 84	10	2,696	6.0
1B-3	661-670	17 Aug 84	10	2,688	6.0

Table 4. M203E2 propelling charge blending study IND 84E-738-1C

Lot no.	Round no.	Date	No. rounds	Muzzle velocity	Velocity standard deviation
1C	120-129	3 Aug 84	10	2,709	10.8
1C	395-404	9 Aug 84	10	2,705	8.8
1C	671-680	20 Aug 84	10	2,690	8.9
1C-1	130-139	3 Aug 84	10	2,701	9.2
1C-1	405-414	10 Aug 84	10	2,700	8.9
1C-1	681-690	20 Aug 84	10	2,687	9.1
1C-2	140-149	3 Aug 84	10	2,702	12.1
1C-2	415-424	10 Aug 84	10	2,703	13.2
1C-2	691-700	20 Aug 84	10	2,697	15.5
1C-3	150-159	6 Aug 84	10	2,710	5.4
1C-3	425-434	10 Aug 84	10	2,704	6.5
1C-3	701-710	20 Aug 84	10	2,689	8.7

Table 5. M203E2 propelling charge blending study summary

Lot no.	No. rounds	Pooled standard deviation
738-1A	30	13.09
738-1A-1	30	4.88
738-1A-2	30	8.55
839-1A-3	30	8.20
738-1B	29	11.25
738-1B-1	30	12.14
738-1B-2	30	8.54
738-1B-3	30	7.04
738-1C	30	9.54
738-1C-1	30	9.07
738-1C-2	30	13.67
738-1C-3	30	7.00

Table 6. Distribution of original trays in subgroup 1 (front quarter of dry houses)

Cabinets from drying bay	
Cabinet no.	Tray no.
1	1-18
2	19-36
3	37-54
4	55-72
5	73-90
6	91-108
7	109-126
8	127-144
9	145-162
10	163-180
11	181-198
12	199-216
13	217-234
14	235-252
15	253-270
16	271-288
17	289-306
18	307-324

Table 7. Distribution of original trays in subgroup 2 (second quarter of dry houses)

Cabinets from drying bay	
Cabinet no.	Tray no.
19	325-342
20	343-360
21	361-378
22	379-396
23	397-414
24	415-432
25	433-450
26	451-468
27	469-486
28	487-504
29	505-522
30	523-540
31	541-558
32	559-576
33	577-594
34	595-612
35	613-630
36	631-648

Table 8. Distribution of original trays in subgroup 3 (third quarter of dry houses)

Cabinets from drying bay	
Cabinet no.	Tray no.
37	649-666
38	667-684
39	685-702
40	703-720
41	721-738
42	739-756
43	757-774
44	775-792
45	793-810
46	811-828
47	829-846
48	847-864
49	865-882
50	883-900
51	901-918
52	919-936
53	937-954
54	955-972

Table 9. Distribution of original trays in subgroup 4 (rear quarter of dry houses)

Cabinets from drying bay	
Cabinet no.	Tray no.
55	973-990
56	991-1008
57	1009-1026
58	1027-1044
59	1045-1062
60	1063-1080
61	1081-1098
62	1099-1116
63	1117-1134
64	1135-1152
65	1153-1170
66	1171-1188
67	1189-1206
68	1207-1224
69	1225-1242
70	1243-1260
71	1261-1278
72	1279-1296

Table 10. Middle of blend 2, distribution of original trays in A cabinets (first four cabinets)

Slot in cabinet	Cabinet 1A	Cabinet 2A	Cabinet 3A	Cabinet 4A
1	1	2	3	4
2	19	20	21	22
3	37	38	39	40
4	55	56	57	58
5	73	74	75	76
6	325	326	327	328
7	343	343	345	346
8	361	361	363	364
9	379	380	381	382
10	397	398	399	400
11	649	650	651	652
12	667	668	669	670
13	685	686	687	688
14	703	704	705	706
15	973	974	975	976
16	991	992	993	994
17	1009	1010	1011	1012
18	1027	1028	1029	1030

Table 11. End of second blend, distribution of original trays in A cabinets after blending and sorting (first four cabinets)

Slot in cabinet	Cabinet 1A	Cabinet 2A	Cabinet 3A	Cabinet 4A
1	1/19	2/20	3/21	4/22
2	1/19	2/20	3/21	4/22
3	37/55	38/56	39/57	40/58
4	37/55	38/56	39/57	40/58
5	73/325	74/326	75/327	76/328
6	73/325	74/326	75/327	76/328
7	343/361	344/362	345/363	346/364
8	343/361	344/362	345/363	346/364
9	379/397	380/398	381/399	381/400
10	379/397	380/398	381/399	381/400
11	649/667	650/668	651/669	652/670
12	649/667	650/668	651/669	652/670
13	685/703	686/704	687/705	688/706
14	685/703	686/704	687/705	688/706
15	973/991	974/992	975/993	976/994
16	973/991	974/992	975/993	976/994
17	1009/1027	1010/1028	1011/1029	1012/1030
18	1009/1027	1010/1028	1011/1029	1012/1030

NOTE: Each tray contains approximately 50% of each tray number shown from blend 1.

Table 12. Middle of blend 3, distribution of original trays in B cabinets (first four cabinets)

Slot in cabinet	Cabinet 1B	Cabinet 2B	Cabinet 3B	Cabinet 4B
1	1/19	95/113	37/55	131/149
2	2/20	163/181	38/56	199/217
3	3/21	164/182	39/571	200/218
4	4/22	165/183	40/58	201/[illegible]9
5	5/23	166/184	41/59	202/220
6	91/109	253/271	127/145	289/307
7	92/110	254/272	128/146	290/308
8	93/111	255/273	129/147	291/309
9	94/112	256/274	130/148	292/310
10	1/19	95/113	51/55	131/149
11	2/20	163/181	38/56	199/217
12	3/21	164/182	39/57	200/218
13	4/22	165/183	40/58	201/219
14	6/23	166/184	41/59	202/220
15	91/109	253/271	127/145	289/307
16	92/110	254/272	128/146	290/308
17	93/111	255/273	129/147	291/309
18	94/112	256/274	130/148	292/310

NOTE: Each tray contains approximately 50% of each original tray number shown in slot of cabinet.

Table 13. End of blend 3, distribution of original trays in B cabinets (first, second and last cabinets)

Slot in cabinet	Cabinet 1B	Cabinet 2B	Cabinet 72B
1	1/19/94/112	95/113/256/274	1185/1203/1278/1296
2	2/20/93/111	163/181/255/173	1186/1204/1277/1295
3	3/21/92/110	164/182/254/272	1187/1205/1276/1294
4	4/22/91/109	165/183/253/271	1188/1206/1275/1293
5	5/23	166/184	1274/1292
6	4/22/91/109	165/183/253/271	1188/1206/1275/1293
7	3/21/92/110	164/182/254/272	1187/1205/1276/1294
8	2/20/93/111	163/181/255/273	1186/1204/1277/1295
9	1/19/94/112	95/113/256/274	1185/1203/1278/1296
10	1/19/94/112	95/113/256/274	1185/1203/1278/1296
11	2/20/93/111	163/181/255/273	1186/1204/1277/1295
12	3/21/92/110	164/182/254/272	1187/1205/1276/1294
13	4/22/91/109	165/183/253/271	1188/1206/1275/1293
14	5/23	166/184	1274/1292
15	4/22/91/109	165/183/253/271	1188/1206/1275/1293
16	3/21/92/110	164/182/254/272	1187/1205/1276/1294
17	2/20/93/111	163/181/255/273	1186/1204/1277/1295
18	1/19/94/112	95/113/256/274	1185/1203/1278/1296

NOTE: A tray contains an equal amount of original tray numbers shown in that slot of cabinet.

Table 14. Middle of blend 4, distribution of original trays in C cabinets (first and last cabinets)

Slot in cabinet	Cabinet 1C	Cabinet 72C
1	1/19/94/112	1009/1027/1102/1120
2	95/113/256/274	1103/1121/1264/1282
3	6/24/167/185	1014/1032/1175/1193
4	168/186/261/279	1176/1194/1269/12[illegible]
5	10/28/103/121	1018/1036/1111/1129
6	104/122/265/283	1112/1130/1273/1291
7	15/33/176/194	1023/1041/1184/1202
8	177/195/270/288	1185/1203/1278/1296
9	2/20/93/111	1010/1028/1101/1119
10	163/181/255/273	1171/1189/1263/1281
11	7/25/99/117	1015/1033/1107/1125
12	169/187/260/278	1177/1195/1268/1286
13	11/29/102/120	1019/1037/1110/1128
14	172/191/264/282	1180/1198/1272/1290
15	16/34/108/126	1024/1042/1116/1134
16	178/196/269/287	1186/1204/1277/1295
17	empty	empty
18	empty	empty

NOTE: A tray contains an equal amount of original tray numbers shown in that slot of cabinet.

Table 15. Final blend/packout, distribution of original trays during final blend (trays being blended on table just before boxing)

Subgroup 1		
Top tray from cabinet	-	1/19/94/112
Bottom tray from cabinet	-	178/196/269/287
Subgroup 2		
Top tray from cabinet	-	37/55/130/148
Bottom tray from cabinet	-	214/232/305/323
Subgroup 3		
Top tray from cabinet	-	73/325/418/436
Bottom tray from cabinet	-	250/502/593/611
Subgroup 4		
Top tray from cabinet	-	343/361/454/472
Bottom tray from cabinet	-	520/538/629/647

↓

BLEND

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YIELD + 3 + boxes

Table 16. Middle of blend B, distribution of original trays in A cabinets

Slot in cabinets*	Cabinets 1A through 18A (subgroup A1)	Cabinets 19A through 36A (subgroup A2)	Cabinets 37A through 54A (subgroup A3)	Cabinets 55A through 72A (subgroup A4)
1	1–18	325–342	649–666	973–990
2	19–36	343–360	667–684	991–1008
3	37–54	361–378	685–702	1009–1026
4	55–72	379–396	703–720	1027–1044
5	73–90	397–414	721–738	104[illegible]–1062
6	91–108	415–432	739–756	1063–1080
7	109–126	433–450	757–774	1081–1098
8	127–144	451–468	775–792	1099–1116
9	145–162	469–486	793–810	1117–1134
10	163–180	487–504	811–828	1135–1152
11	181–198	505–522	829–846	1153–1170
12	199–216	523–540	847–864	1171–1188
13	217–234	541–558	865–882	1189–1206
14	235–252	559–576	883–900	1207–1224
15	253–270	577–594	901–918	1225–1242
16	271–288	595–612	919–936	1243–1260
17	289–306	613–630	937–954	1261–1278
18	307–324	631–648	955–972	1279–1296

*A slot contains 1/18th (20–25 sticks) of each original tray numbers shown in that slot. All cabinets in a subgroup contains the same mixture in a given slot.

Table 17. End of blend B, distribution of original trays in B cabinets

Subgroup B1	
(cabinets 1B-18B)	Each tray contains approximately 1/324th (1-2 sticks) of each original tray from subgroup 1 (cabinet 1-18, trays 1-324.
Subgroup B2	
(cabinets 19B-36B)	Each tray contains 1/324th of each original tray from subgroup 2 (cabinets 19-36, trays 325-648).
Subgroup B3	
(cabinets 37B-54B)	Each tray contains 1/324th of each original tray from subgroup 3 (cabinets 37-54, trays 649-972).
Subgroup B4	
(cabinets 55B-72B)	Each tray contains 1/324th of each original tray from subgroup 4 (cabinets 55-72, trays 973-1296).

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