Test Results, Conclusions, and Next Steps in the Analysis of Factors Contributing to Variability in Web Offset Color Advertising Reproduction

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Abstract: The 1983 Spectrum test effort provided the Graphic Communications Association's Print Properties Committee with a better understanding of the mean and range of dot gain and density among heat-set web offset publication printing presses. Results prompted the Committee in 1984 to design a multi-condition test at one printing location to analyze more specifically the primary factors contributing to dot gain. Subsequently, a controlled, seven-site test focused on control of factors found to be key contributors and explored further the application of GCA Publication Advertising Reproduction (PAR) Curves. The paper reviews the history of Spectrum test efforts, results of the 1984 test, plus offers a preview of the 1985 test effort. This 1985 test focuses on additional ink-related testing and the application of Spectrum results in the reproduction of "live" advertising.

In his paper, "Further Analysis of Factors Contributing to Variability in Web offset Color Advertising Reproduction," published in last year's TAGA Proceedings, GCA President Norman W. Scharpf outlines the history of the Spectrum Test efforts and the "Spectrum Spirit" guiding these efforts. Quoting his description briefly, "Spectrum is a continuing program to bring together management repesentatives from advertising agencies and their clients, separation houses, publishers, printers, and suppliers to improve levels of communication and coordination among industry segments, and otherwise to

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create a better climate for the application of current and future technologies to national ad production." The means of achieving the Spectrum spirit are also defined as "Education, dialogue and research."

A brief review of Spectrum research efforts is also in order. The Print Properties Committee, comprised of representatives of all the links in the color reproduction chain, has the mission of targeting the causes of ad reproduction variability and determining the means for its control. Spectrum test efforts, which are undertaken in production settings, attempt to translate and interpret laboratory research for those who can use it to refine the ad production process.

A listing of the test efforts reveals the Committee's analytical progress:

1979 -- the Committee investigated paper surface characteristics to determine their influence on printed results. The conclusion: optical paper properties are not as important as control of separation films and printed reproduction. This test also indicated significant optical differences existed between specified proofing stocks and production stocks.

1980 and '81 -- The Committee spent time further analyzing the proofing stock/production stock difference and the impact this has on ad reproduction. In addition to confirming that tone reproduction curves created for optically brighter paper would print with more difficulty and less consistency on production stocks, the Committee acknowledged that control of dot gain, especially in the 40 to 60 percent middle tones, was of critical importance to consistent ad reproduction.

1982 -- In a test that has been reported on at TAGA '83, the Committee confirmed mid-tone dot gain as a prime cause of variability in a test involving sixteen heatset web offset publication printers. Test instructions requested that after completing the press run of a production form, the printer was to hang new plates for one side of the sheet containing test targets and images. The press crew was then instructed to run the press so that the side of the sheet still using the production form plates would be printed to match sheets printed during the production run. Test results indicated that mid-tone dot gain was a major cause of reproduction variability. More importantly, the 1982 effort pointed out that production press dot gain was higher that proofing press dot gain, and that separations tailored to proofing stocks that are optically brighter than production sheets were difficult to match on press.

1983 -- The Committee's next step was clear: to discover what amount of mid-tone dot gain might be built into color separations so that production press images could be more readily printed to match the proofing press image. Thirty production presses were involved in the effort, reported on last year at this meeting. That paper discussed at length the many conclusions drawn from this test, but basically this curve--we call it the Publication Advertising Reproduction, or PAR, Curve, generated by Eastman Kodak from information derived from the Kodak Color Analyzer Target included on all 1983 test forms, approximates an average tone reproduction curve of the thirty presses. Kodak also provided images of curves for presses having more and less gain in the mid-tone regions.

The Committee drew two major conclusions from the 1983 Kodak analysis, which suggested that:

a. a wide range of dot gain was being printed throughout the industry, a factor indicating the need for greater awareness of process control tools and procedures.

b. with improved pressroom controls, a "window" of publication production dot gain could be established that would provide color separators a target of mid-tone dot gain that could be built into separations.

Thought was also given as to why the range of dot gain was so great, with the conclusion being that pressroom factors, both mechanical, such as press speed and bearer pressure, and material, such as ink, blankets, and fountain solution, required further study.

Our first 1984 effort was consequently directed to discovering what were the principle pressroom variables that were causing the dot gain variation. We thus began 1984 efforts with an extensive presroom test at the PennWell Printing Company, who generously provided 32 continuous hours of press time. Crown Zellerbach donated 16 rolls of paper for the test, ensuring that this material would not be a test variable, and Sinclair and Valentine provided the ink. Numerous volunteers from the Print Properties Committee also participated. The test form contained the quarter-page Brunner form, the GCA/GATF Proof Comparator, Kodak Color Analyzer, a Harris Graphics ladder target, GATF Color Control Bar, 3M plate exposure control devices, and four type of images separated to both conventional and PAR aimpoints, i.e., with differing amounts of mid-tone dot gain. After detailed committee discussions on the likely major causes of pressroom variability, the group chose six for the test to focus on: printed ink density; ink strength; press speed; the effect of multiple impressions; roller settings; and bearer settings. The committee specified what conditions were required to exist on press in order to test these six possible dot gain contributors and listed the sequence in which these conditions would occur. We ended up with 19 conditions, which we felt would take 32 hours, with four conditions in reserve.

Test results were exciting. First, out of the six tested responses, ink strength proved to be the only a significant contributor to dot gain. Additional testing was recommended to clarify this result and to suggest the specific relationship between ink strength and dot gain. Second, we found that variations caused by the press' mechanical action could overwhelm small dot gain differences caused by another factor. Third, we were able to graph the relationship between solid ink density and dot gain.

The next phase of the 1984 test was clear. We needed to: refine dot gain and density windows for production publication presses; confirm the need to build dot gain into tone reproduction curves of separations being printed on these presses; show again the value of test targets as key tools in process control; show that separations that allowed for the dot gain typical of production presses would print in a more uniform manner; and, finally, better understand what pressroom factors were in need of greater industry attention.

Armed with these goals and PennWell Press Test results, the Committee designed a test that was notable for its scope and the cooperation that it required of the participating printers, publishers, separators, and suppliers.

A test form was designed to encompass the Brunner quarter page form and color bar, the GCA/GATF Proof Comparator, the Kodak Color Analyzer, GATF Color Control Bar, UGRA Plate exposure control scales, 3M Sensitivity strips, and four images separated to Conventional, PAR, Low-PAR, and High-PAR aimpoints. Eastman Kodak developed new images specifically for use in this test effort, with three of the pictures comprised of a secondary color of red, green, or blue plus a fourth neutral to aid in the visual interpretation of numeric test results. I would emphasize that the significant difference between the four sets of separations of these four images was in the amount of mid-tone dot gain that had been built into each, with tone reproduction curves growing flatter as the separations moved from Conventional, to Low-PAR, PAR, and High-PAR. Because ink was the variable being tested, Crown Zellerbach again provided the Print Properties Committee with a uniform paper supply--a total of 32 rolls. Over 30 other paper companies, printers, publishers, color separators, ad agencies, and suppliers generously underwrote the remaining costs associated with the stock. Seven publication printers, including Brown Printing, the William Byrd Press, Shenandoah Valley Press, World Color Press, R.R. Donnelly/Mattoon, W.R. Bean, and Baird Ward Printing Company participated by donating a shift of press time, Over 20 members of the Print Properties Committee worked together on teams at press side, taking samples, making measurements, and following up with myriads of other test details. Extensive analyses by supplier members of the Committee followed. Nearly 75 different organizations contributed to this truly industry-wide effort.

Test procedures asked that each printer submit ink samples to their supplier, who would provide a modified test set with a pigment strength uniformly increased by 15%. Plate exposures were carefully monitored at each site by the staff of Brunner systems, courtesy E. I. DuPont. Test procedures were outlined, including densitometer use. In each pressroom, the test form was printed to a series of six master conditions, each condition using the GCA-provided stock. Conditions 1, 2, 5, and 6 allowed comparisons of:

-- sheets printed using production ink to specified densities and sheets printed using production inks to a visual match with a supplied proof.

-- sheets printed using production inks to specified densities and sheets printed using higher strength inks to specified densities.

-- sheets printed using production inks to a visual match with a supplied proof and sheets printed with higher strenth inks to a visual match with a supplied proof.

-- sheets printed with higher strength inks to specified densities and sheets printed with higher strength inks to a visual match with a supplied proof.

These four conditions were the core of the test effort, but testing was dynamic, with additional master conditions, such as one asking for two-sided printing in order to evaluate blanket release, being added at the printing site.

Figures 1 through 7 describe test definitions and contain some of the data analyses, which included paper, ink, fountain solution, and an extensive evaluation of printed sheets. Results surprised us, both because they confirmed the value of a tone reproduction curve for production press work and because they did not support the PennWell Press test result that ink strength alone is a major contributor to dot gain. Ink was, however, acknowledged as being critical to the control of dot gain, and is cited as one of the eight conclusions drawn from the 1984 test. Test results also pointed out the importance of contrast, which is the degree that the shadow tones can hold detail; emphasized that dot gain had to be consistent among the three process colors; indicated that plate exposure was an important prepress step in control of dot gain; and allowed us to define the normal operating ranges of publication press dot gain and density. All this information allowed us to develop "windows" for these characteristics.

The seven 1984 Spectrum press test conclusions, which were reported to the SWOP Dot Gain Subcommittee to assist their efforts in the revision of the SWOP Specifications, are:

1. The normal operating range of dot gain for web-offset, heatset publication presses printing on #5 coated groundwood stock is 22% ± 4% using the GATF 120-line 40% square dot target.

2. The normal operating ranges of solid ink densities for web-offset, heatset publication presses printing on #5 coated groundwood are:

cyan	1.19 ± .10
magenta	1.31 ± .10
yellow	1.00 ± .10
black	1.55 ± .10

(Note: density measuremments used to develop these numbers were made with the paper "zeroed" out. Also, high-low ink density references, such as those under consideration by the SWOP Committee for use in press proofing, need to be printed using #5 coated groundwood in order to guide printers to print within these ranges.)

3. Separations for web-offset, heatset publication presses using "production" inks and #5 coated groundwood should be based on the following parameters:

   a. paper brightness for the highlight values

   b. equivalent dot gain of 22% for the mid-tone values (see conclusion #1)

   c. solid ink densities based upon results in #2

   d. Further refinements of results pertaining to the 1/4 and 3/4 tone (contrast) values are needed.

4. The normal operating range for print contrast should be no less than 25. The equation used to calculate

this value is:

$$\frac{\text{(Solid Ink Density)} - \text{(Density of 75\% Tint)}}{\text{(Solid Ink Density)}} = \text{Print Contrast}$$

5. The dot gain balance on the printed sheet should be within a 3% spread among the cyan-magenta-yellow printers.

6. Today, inks should be formulated to help printers achieve a normal operating range for dot gain of 22% ± 4%.

7. A microline scale should be used in combination with a continuous tone scale to control plate exposures.

Note: These normal operating ranges were developed using the GATF 120-line 40% square dot and analyzed wuth a status-T densitometer using the Murray-Davies formula. If the printer uses any other target or densitometer, he should rely on the manufacturer's recommendations to interpret normal operating range results.

Industry response to this information has been exciting. In addition to providing valuable research data to industry specifications groups such as SWOP, we have been told that increasing numbers of printers, separators, ad agencies, and suppliers are using this data to examine and modify their internal processes to improve productivity and coordination with the other segments of the ad reproduction chain.

The 1985 test is pursuing several trails uncovered by the 1984 effort. After careful consideration, ink company members of the Print Properties Committee have designed a test devoted to investigating ink properties--including ink strength--to better grasp the interrelatedness of the components of this key material and their influence on printed reproduction. Key objectives for this test, now underway, include:

1. achieving a more thorough understanding of the critical ink film thickness curve described by the PennWell Press Test results and determining the visual correlation between the printed reproduction and the

location on the curve of the ink film thickness of that printing.

2. greater industry understanding of the interrelationships of ink components, the relative influence that each component has on printing variability, and a description of how the industry should approach the development of appropriate inks in order to print within normal operating range tolerances.

3. improved industry understanding of how printers can reach dot gain levels at the bottom of or below the normal operating range of 22% ± 4% so that we can potentially narrow this range or move it lower.

4. potential development of recommendations and guidelines for the industry.

Test efforts in 1985 have also focused on the application of PAR Curve data to live situations. An additional exciting development in 1985 is that the Spectrum test efforts have served as a catalyst for individual test efforts by Print Properties Committee members. These tests include additional applications research into the optical properties of proofing and production stocks, gray component replacement, and the impact of fountain solution on dot gain variance.

In summary, let us review the SPECTRUM goal: to find the means for control of variability in advertising reproduction. Having provided a wider industry audience with knowledge of dot gain and the need for its control, we are now tracking major dot gain contributors--procedural, material, mechanical--in a effort to help the industry find the controls to improve productivity and ad quality. The SPECTRUM goal requires a total-industry perspective and a systems approach to minimizing variability. As always, we welcome the recommendations and assistance of all the TAGA membership in our past and future efforts, to assure proper direction and practicality in our research toward these goals.

GLOSSARY

DOT SIZE PLATE	-	Size of 40% dot on plate surface.
DOT SIZE PRINT	-	Apparent dot area on sheet of 40% film dot. This includes physical and optical gain on GATF scale.
DOT GAIN PRINT	-	Per cent dot gain in 40% tint (i.e., this equals dot size in print minus 40).
BRUNNER DOT GAIN	-	Density difference between fine line and coarse line screen on 50% dot measured on Brunner scale.
HUE ERROR	-	Deviation from perfect hue of any process color.
GRAYNESS	-	Measure of grayness in process color.
% TRAP	-	Measure of % difference between solid on paper versus solid second color down.
EFFICIENCY	-	Measurement of how good process color performs.
SLUR	-	Reference on GATF slur gauge.
SATURATION	-	Amount of "color" in process and over-print colors.
CONTRAST	-	How much 75% screen differs in density from a solid.

FIGURE 1

PAPER PROPERTIES FOR

SPECTRUM '84 TEST

	AVERAGE	HI	LO
BRIGHTNESS	71	73	68
PAPER GLOSS 75°	41	47	34
OPACITY	90	92	88
L	86	87	85
a	.02	.25	-.16
b	3.79	4.38	3.10
K & N	.11	.12	.10

FIGURE 2

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GCA 1984 PRESS TEST

TEST #	ALC.	PH	PRESS SPD TEST	PPR SURF TEMP	OVEN TEMP	CHILL ROLL TEMP	CHILL ROLL #	PRESSROOM TEMP	PRESSROOM HUM	DOT SIZE PLATE Y	DOT SIZE PLATE M	DOT SIZE PLATE C	DOT SIZE PLATE K	DOT GAIN PRINT Y	DOT GAIN PRINT M	DOT GAIN PRINT C	DOT GAIN PRINT K	GREY SCALE Y	GREY SCALE M	GREY SCALE C	GREY SCALE K
GCX101	15	4.25	1300	325	400	65	6	85	45	44	44	44	44	11	14	13	18	4.00	4.00	4.00	4.00
GCX105														13	15	18	20				
GCX301	15		1100	275	350	60	4	72	70	41	42	42	42	18	23	22	22	3.00	5.00	3.50	4.80
GCX305														16	24	23	23				
GCX401		3.90	900	275	375	65	3	88	55	43	43	43	42	19	24	28	23	5.00	5.00	5.00	4.00
GCX405														23	24	25	20				
GCX501		4.00	600	350	400	62	4	99	79	34	35	34	37	12	17	22	20	5.90	5.90	5.90	5.90
GCX505														12	18	17	20				
GCX601		3.60	1100	280	345	48	4	85	75	42	43	43	42	33	28	30	29	5.00	5.00	5.00	5.50
GCX605														27	28	29	37				
GCX701	15	4.00	900	320	420	85	3	80	70	34	33	35	35	16	17	13	18	5.00	5.00	5.00	5.00
GCX705														14	19	14	21				
GCX801		3.50	700	320	425	55	4	78		42	42	42	42	25	20	22	24	4.00	4.00	4.00	4.00
GCX805														26	20	22	29				
MPNEGD														22	24	23	26				
MPPOSD														18	19	19	20				

FIGURE 3

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GCA 1984 PRESS TEST - CONTINUED

TEST #	HUE ERROR			GREYNESS			HUE ERROR			HUE INK			GREY INK			CONTRAST				MAJOR FILTER DENSITY			
	Y	M	C	Y	M	C	R	G	B	Y	M	C	Y	M	C	Y	M	C	K	Y	M	C	K
GCX101	10	50	20	13	19	20	-90	71	97	8	49	20	2	10	9	28	30	33	32	1.25	1.42	1.38	1.45
GCX105	9	50	20	14	20	22	-87	79	93	6	48	20	3	12	9	28	30	28	31	1.14	1.36	1.30	1.57
GCX301	10	48	20	15	20	22	-97	77	80	7	46	20	4	12	11	19	17	25	25	1.16	1.46	1.34	1.53
GCX305	12	46	20	15	20	22	98	61	97	10	44	20	4	12	10	23	17	22	24	1.14	1.41	1.34	1.59
GCX401	9	47	17	12	20	20	-97	60	100	6	44	18	1	12	8	8	22	20	28	1.13	1.43	1.44	1.63
GCX405	7	46	18	12	19	22	-84	81	93	6	44	19	2	11	9	8	26	19	29	1.23	1.39	1.30	1.40
GCX501	8	44	19	13	19	20	-99	61	100	5	42	19	3	12	10	25	27	21	21	1.20	1.53	1.44	1.69
GCX505	9	46	21	13	19	22	94	90	51	7	43	22	2	12	9	28	30	27	33	1.17	1.57	1.21	1.56
GCX601	10	50	18	12	18	24	-85	81	79	8	47	19	2	10	11	12	13	19	8	1.25	1.43	1.36	.91
GCX605	10	54	21	14	20	23	-93	65	62	6	51	21	3	12	10	13	14	19	14	1.14	1.38	1.29	1.58
GCX701	7	50	20	11	18	22	-85	95	65	5	48	20	1	11	8	21	27	35	27	1.28	1.47	1.20	1.43
GCX705	7	49	20	12	19	24	-89	96	55	5	46	21	2	12	10	24	27	34	24	1.22	1.54	1.18	1.44
GCX801	11	49	19	13	22	23	-96	77	93	8	45	20	2	14	10	15	18	21	25	1.19	1.37	1.28	1.41
GCX805	10	47	19	13	21	21	-95	81	83	7	45	19	3	13	9	14	22	23	22	1.21	1.45	1.28	1.50
MPNEGD	7	48	20	10	20	20	-92	77	81	4	46	20	1	15	10	24	28	29	33	1.14	1.43	1.37	1.67
MPPOSD	7	50	18	14	18	24	-90	88	73	4	47	19	3	10	11	25	29	30	39	1.14	1.36	1.27	1.73

FIGURE 4

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GCA 1984 PRESS TEST - CONTINUED

TEST #	EFFICIENCY Y	M	C	% TRAP R	G	B	PAPER DENSITY R	G	B	SATURATION Y	M	C	SATURATION R	G	B
GCX101	83	61	72	54	69	61	.14	.16	.17	1.04	1.00	1.01	1.19	.70	.58
GCX105	82	60	71	57	75	61	.13	.16	.17	.94	.94	.94	1.12	.67	.52
GCX301	81	61	70	57	74	68	.13	.16	.17	.94	1.01	.95	1.18	.67	.61
GCX305	80	62	71	54	71	63	.13	.16	.17	.92	.98	.96	1.13	.70	.61
GCX401	84	62	73	55	70	64	.13	.16	.18	.95	1.00	1.06	1.14	.76	.62
GCX405	85	62	72	63	72	63	.13	.15	.17	1.04	.97	.94	1.20	.72	.57
GCX501	84	63	72	52	66	60	.12	.15	.16	1.01	1.08	1.06	1.19	.72	.64
GCX505	83	62	69	51	74	63	.13	.15	.17	.98	1.10	.86	1.21	.65	.55
GCX601	84	61	69	57	68	62	.13	.16	.18	1.05	1.01	.96	1.21	.66	.53
GCX605	82	59	69	51	65	67	.13	.17	.18	.93	.96	.90	1.14	.62	.51
GCX701	86	61	70	59	75	65	.13	.16	.17	1.10	1.04	.86	1.27	.71	.53
GCX705	84	61	69	61	76	72	.13	.16	.18	1.03	1.08	.82	1.28	.69	.60
GCX801	83	59	70	54	70	60	.13	.16	.18	.99	.93	.91	1.14	.67	.53
GCX805	83	61	71	55	72	63	.13	.16	.17	1.00	1.00	.93	1.17	.67	.55
MPNEGD	87	60	72	67	82	78	.10	.13	.14	1.00	.99	1.01	1.25	.74	.64
MPPOSD	83	61	69	63	77	74	.13	.16	.18	.95	.96	.89	1.19	.69	.55

FIGURE 5

GCA 1984 PRESS TEST - CONTINUED

	E.S. CONDUCTIVITY								E.S. PH				E.S. TOTAL ACIDITY				WATER PICK-UP			
	YEL		MAG		CYAN		KEY													
TEST #	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	YEL	MAG	CYAN	KEY	YEL	MAG	CYAN	KEY	YEL	MAG	CYAN	KEY
GCX101	1000	1200	1100	1200	1200	1350	900	1050	4.90	4.70	4.70	4.80	725	725	725	725	40	15	34	36
GCX105	1100	1300	1100	1200	1100	1200	1100	1250	4.70	4.70	4.70	4.70					34	32	40	32
GCX301	500	600	800	800	700	750	550	900	4.00	4.00	3.90	4.00	365	365	365	365	42	36	46	36
GCX305	600	650	800	850	600	650	600	900	4.00	3.90	3.90	4.10					52	36	36	30
GCX401	5000	5000	5000	6500	5000	5000	5000	5300	3.90	3.90	3.90	3.90	1459	1459	1459	1459	56	34	50	48
GCX405	4800	4900	4800	4900	4800	4900	4800	5200	3.90	3.90	3.90	3.90					48	26	42	48
GCX501	1050	1100	1100	1200	1050	1150	1100	1300	4.30	4.30	4.30	4.30	941	941	941	941	58	38	44	36
GCX505	1000	1050	1000	1200	1000	1100	1000	1300	4.10	4.10	4.10	4.10					56	42	52	44
GCX601	1950	2100	1950	2200	1950	2050	1950	2250	4.00	4.00	4.00	4.00	461	461	461	461	34	30	38	38
GCX605	2000	2000	2000	2200	2000	2200	2000	2800	4.00	4.00	4.00	4.00					42	36	48	34
GCX701	1000	1050	1000	1200	1000	1050	1000	1200	3.90	3.90	3.90	3.90					40	44	40	38
GCX705	1000	1050	1000	1150	1000	1050	1000	1400	4.00	4.00	4.00	4.00					40	36	36	36
GCX801	2200	2300	2200	2550	2200	2200	2200	2350	3.60	3.60	3.60	3.60	768	768	768	768	30	32	42	36
GCX805	2200	2350	2200	2500	2200	2200	2200	2400	3.60	3.60	3.60	3.60					30	32	40	34

FIGURE 6

GCA 1984 PRESS TEST - CONTINUED

TEST #	VISCOSITY				YIELD VALUE				BLEACH TEST				INKOMETER-1 MIN.				STABILITY			
	Y	M	C	K	Y	M	C	K	Y	M	C	K	Y	M	C	K	Y	M	C	K
GCX101	130	98	119	115	5500	13000	14000	9000	0	-35	-5	-25	8.3	7.7	10.0	8.7				
GCX105	100	118	105	88	10500	14500	9000	8000	15	-10	15	-7	7.3	8.2	8.9	8.2				
GCX301	178	240	256	158	16000	27000	17000	23500	-50	-35	10	-25	8.9	10.0	11.0	9.1				
GCX305	130	112	130	118	22000	25500	29000	30000	-40	-12	25	-25	9.3	7.9	8.2	7.0				
GCX401	81	101	185	110	4000	28000	10000	9000	-90	-10	-30	-37	7.4	9.1	11.2	10.2				
GCX405	80	132	100	105	6000	22000	18000	5500	-50	-30	-20	-25	7.4	9.5	10.7	11.0				
GCX501	139	145	165	118	8000	14000	13000	14000	-15	-20	-15	-30	11.0	11.4	11.8	9.2				
GCX505	145	180	140	125	10500	10000	13000	10000	-5	-5	7	-20	12.2	12.0	13.1	10.4				
GCX601	145	232	275	105	16000	10500	7500	11500	-27	-15	-5	-22	9.7	10.2	11.6	9.1				
GCX605	125	204	245	150	13500	13000	12500	14500	-7	-15	15	-10	9.3	10.2	10.8	10.1				
GCX701	110	163	163	153	11000	12000	13000	12000	-80	-30	5	-40	10.0	11.5	12.2	11.0				
GCX705	122	128	202	178	15000	14000	13000	11000	-60	-15	25	-25	9.2	11.0	12.5	11.4				
GCX801	97	138	104	95	14000	18000	11000	9000	0	0	25	-17	7.8	8.6	9.0	8.0				
GCX805	94	142	99	92	17000	16000	10000	11500	15	15	30	-10	7.6	8.6	8.8	8.1				

FIGURE 7