ROD MILL BILLET SURFACE QUALITY REPORTING SYSTEM

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INTRODUCTION

The Rod Mill Billet Surface Quality Reporting System that was developed for Bethlehem Steel's No. 3 Rod Mill was designed to provide a mechanism for tracking and reporting on the surface quality of rod mill billets so that management could ensure production of quality rod products. The system was developed over the past two years and was designed to fill the needs of the General Management, Quality Assurance and Operating Departments at both the Bar, Rod and Wire Division, which manages the mill, and the Sparrows Point Plant, which supplies most of the billets. The need for a reliable and comprehensive quality monitoring system at this mill was particularly acute because the billets are sourced from both ingot and caster steel produced at multiple locations. Even during normal operation, there are multiple points for inspection, surface preparation and rejection. This system was designed to monitor surface quality at all points, to relate any quality problems back to their appropriate source, and to compare the quality of billets from different sources (e.g. Johnstown and Sparrows Point Plants) and/or different processes (e.g. ingot and caster).

BACKGROUND

Before describing the billet surface quality system, we will start with a brief overview of the steelmaking process with particular emphasis on those aspects that impact the system. As shown schematically in Figure 1, the making of steel is a batch process which requires refining of molten iron to steel in one of three types of melting furnaces to remove impurities. The batch of liquid steel, which is called a "heat" of steel, will typically weigh about 250 tons when the refining is completed. This liquid steel is cast into a solid shape in one of two manners -- continuous casting or ingot pouring. In either case, the molten steel is transferred to a bottom-pour ladle for movement to the casting area. In the case of the newer continuous casting, the molten steel is poured into a trough-like reservoir called a tundish that controls the flow of the steel through a water-cooled permanent mold which controls its shape as it solidifies into a continuous ribbon-like slab of steel which is typically 8-10 inches thick by 36-86 inches wide and may be thousands of feet long if it involves the sequential pouring of a number of heats. In the case of the older ingot process, the molten steel is poured into a series of smaller ingot castings -- perhaps 2x4x8 feet. Each heat will produce about 20 ingots which are reheated in a soaking pit and rolled down to a bloom (essentially a rectangular slab) in a blooming mill. In either case, the slab/bloom is reheated in another furnace and then rolled down into a billet which, in the case of the No. 3 Rod Mill, would be 30 feet long with a four-inch, round-cornered square cross-section. These billets would, in turn, be reheated and rolled to rod which is a wire-like final shape that is typically 0.1-0.5 inch in diameter and is sold in 1000-5000 pound coils. The quality of the final rod is strongly correlated with the surface quality of the starting billet; therefore, to ensure the production of the highest quality rod, we must have billets with a defect-free surface.

As shown in Figure 2, the processing of billets into rod at the No. 3 Rod Mill involves both caster and ingot steel from multiple sources. Tracking and monitoring of billet surface

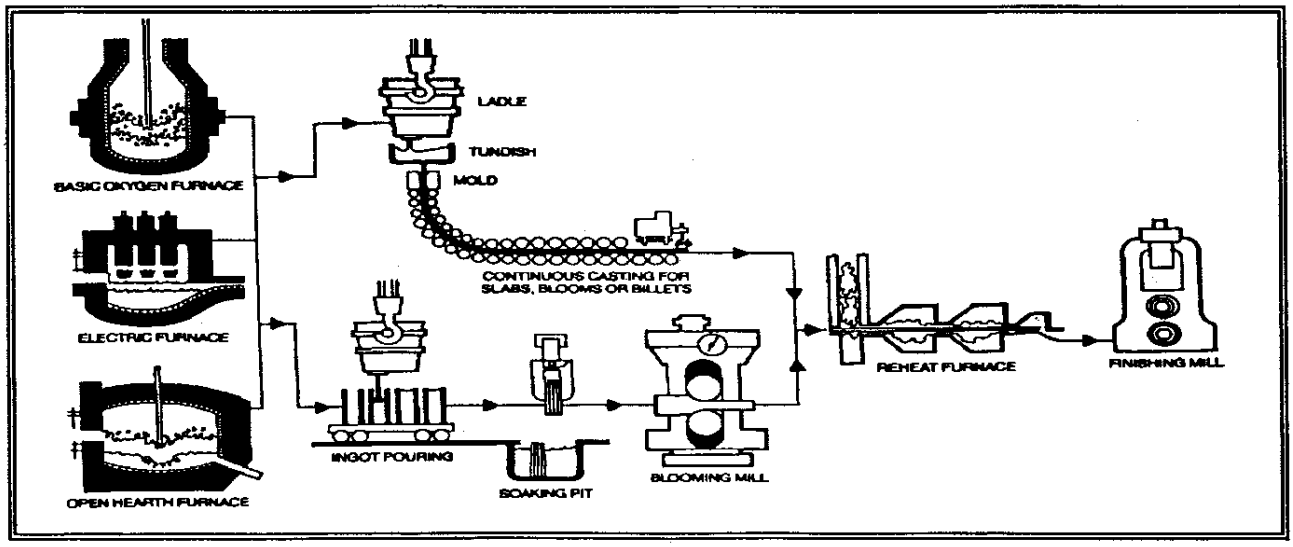


FIGURE 1: Overview of Steelmaking Operations

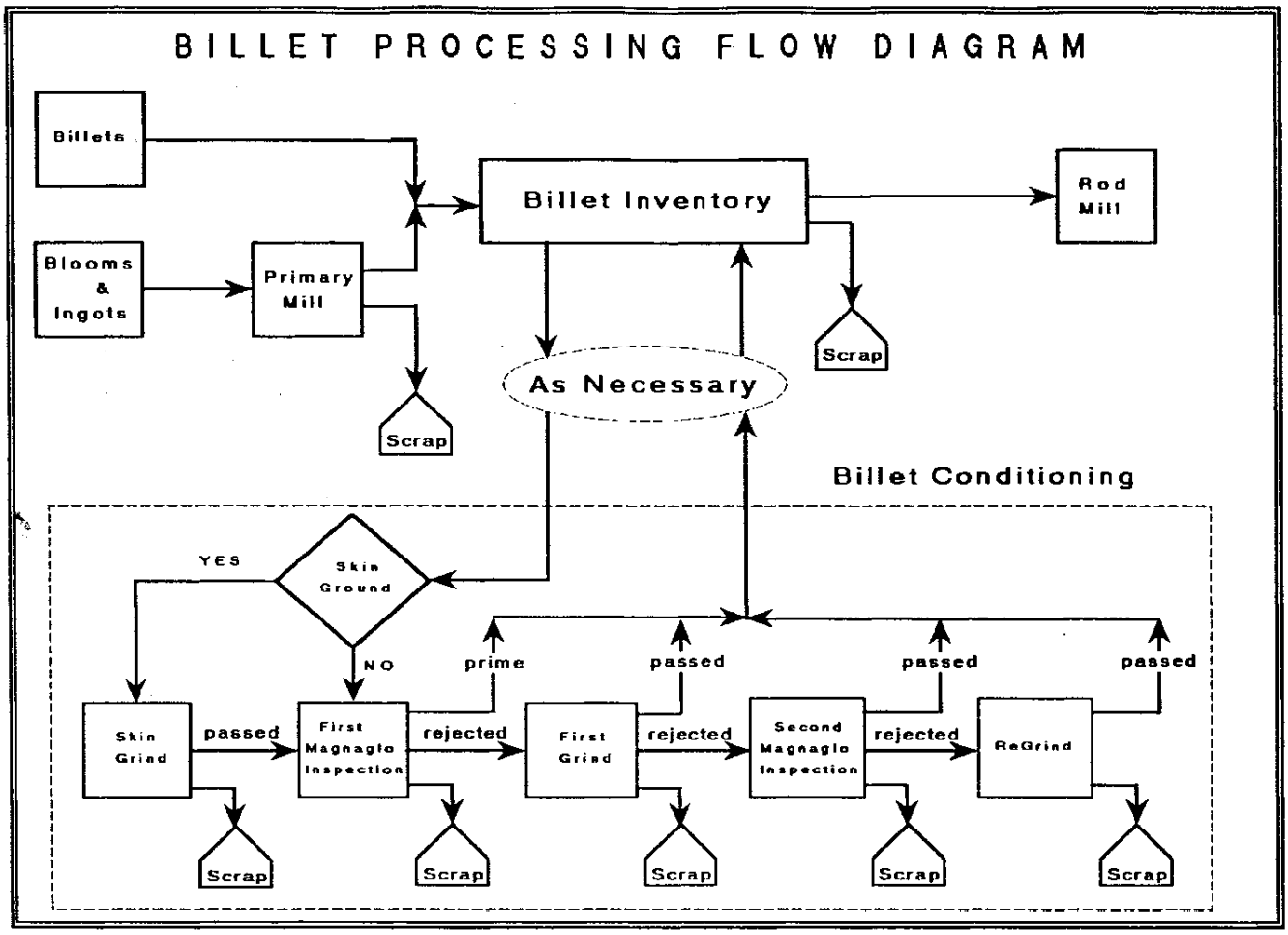


FIGURE 2. Overview of Rod Mill Operations

quality is further complicated by the fact that the defects occur infrequently and, depending on the source and the final product, there may be multiple points for inspection, surface preparation and rejection. Therefore, a reliable and comprehensive quality monitoring system was required to collect, summarize and report surface quality data and relate the observed defects back to their assignable cause. For example, a billet shape problem would be related to a specific operation in the billet rolling process whereas other defects would be related to the steelmaking, casting, or ingot-rolling processes.

SYSTEM OVERVIEW

The system was designed in cooperation with the users as a four-step operation to minimize interference with other rod mill operations. All four operations -- data entry, data validation, file building and report generation -- were combined into one user-friendly, menu-driven, SAS-based computer system. It will handle billets produced by different sources and, when appropriate, will generate separate summary reports for each source. Standard classifications of defects and billet steel grades were established as part of the development of this system. User ID-level security is used to restrict access to the data-entry and file-building functions while allowing general access to the report generation functions and reading the data files for generating ad hoc reports. Finally, the system includes extensive on-line and written documentation as well as a large number of Help screens to aid the users.

Data entry is simplified by using formatted (i.e. fill-in-the-blank) screens that emulate the arrangement of data on the existing grinder surface preparation and magnaglo inspection production reports from the conditioning areas. Scrap data are also collected from the billet receiving and storage yard reports and from the rod mill's inventory and billet charging systems. In order to minimize interference with other users while maintaining the highest degree of data accuracy, all data are initially stored in transaction data files for validation and correction of any errors before they are added to the process and heat summary data files. These latter historical summary files are well documented and will be retained indefinitely to serve as the basis for future inductive studies to relate quality to metallurgical and process parameters.

Eight different kinds of standard reports are included in the system. These reports range from detailed quality engineering reports through successive levels of increasingly summarized management information, quality trend and scrap summary reports. The quality engineering

reports are used by the Steelmaking and Primary Mills engineers to relate quality and process changes and generate SPC charts on a heat-by-heat basis within grade groups. There are two distinct formats used for the engineering reports depending on whether the billets from that group are normally sent to billet conditioning or used directly from the Primary Mill. In addition, to permit the quality engineers to focus easily on a specific problem, the detailed reports can be limited to a specific grade group of billets and/or a specific time period by proper choice of run-time options.

SYSTEM DESIGN

The system was designed as a four-step operation consisting of data entry, data validation, data file building and report generation. It was configured in this manner to minimize interference with other rod mill operations. The data entry should be done in a timely manner, preferably daily, while the data validation and data file building steps need be done only several times a week on a time-available basis or as needed for report generation. All reports may be run on a demand basis.

The data validation procedure checks for data consistency and mathematical accuracy. For example, data from the steelmaking chemistry file and the primary mills system are used to determine if the heat numbers and grades are valid. Also, since billets are scrapped for specific reasons, another one of the checks determines if the total number of scrapped billets is equal to the sum of the number of billets scrapped for each specific reason.

Four TSO cataloged sequential quality history files are generated by the system. These files consist of three files that record the daily quality information for the grinding, magnaglo and yard areas and a fourth file that contains a summary of the performance of each heat.

The system is written in SAS using the SAS/AF facility, which is a user friendly system of menus and fill-in-the-blank screens that allow the user to generate reports, and from certain authorized IDs to also enter, edit/browse data and run programs to update the permanent Rod Mill data files.

Help screens are available from almost anywhere within the system. Screens that do not accept user input anywhere except on the command line have one level of help, whereas screens that will accept user inputs from other parts of the screen contain two levels of help.

SYSTEM OPTIONS

As shown in Figure 3, the reporting system has been divided into six major functional areas -- three that are available to the general user community and three involving data entry and file generation that are limited to a select few authorized users. These system options have been translated into two SAS/AF main menus -- one for the restricted users that contains only the first three options and the other one for the authorized users that contains all six options.

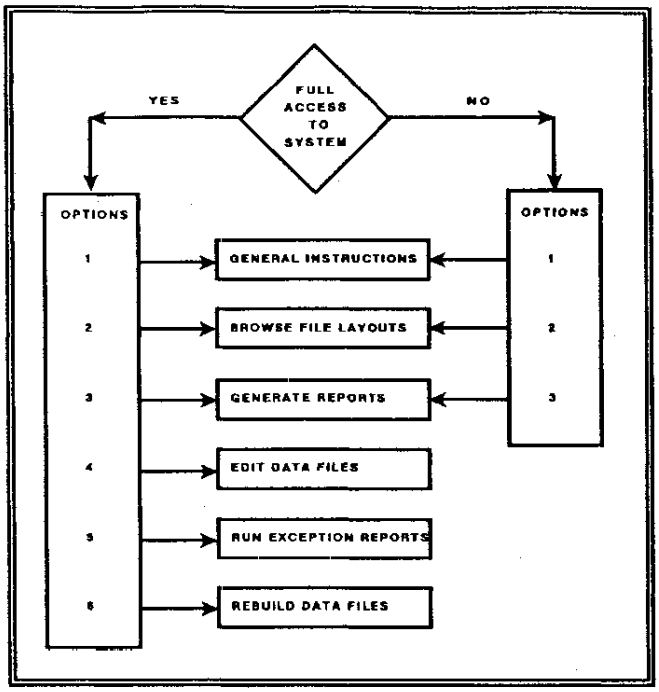


FIGURE 3. System Overview

Figure 4 shows the latter, six-option SAS/AF Main Menu -- the one that is restricted to certain computer users. All other users, (i.e. those who do not have authorization to edit or update files) will see a similar screen that shows only options 1 thru 3.

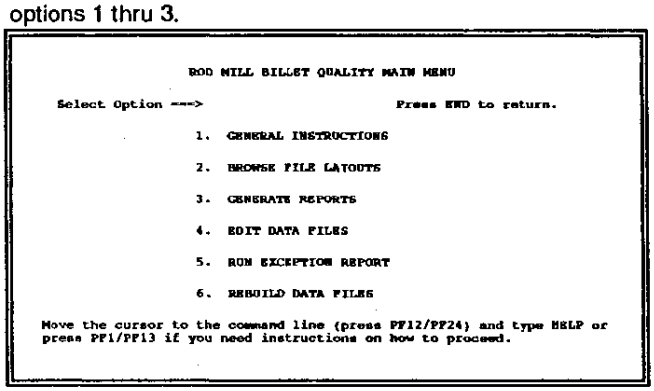


FIGURE 4. SAS/AF Main Menu

General Options

As discussed above, the first three of these system options are available to all users.

SYSTEM OPTIONS 1 & 2

The first two options are self explanatory. Option 1 will give some general instructions concerning the use of the system -- essentially an on-line version of the user's manual; option 2 permits browsing of the layouts of the four main data summary files that are generated by this system.

SYSTEM OPTION 3 - Generating Reports

When option 3 is selected, the screen shown in Figure 5 will appear. The main function of this screen is to allow the user to change the default values that will be entered on the job card which will be submitted as part of the batch job that will be run to generate the reports. Any changes to these data fields, which are initially set to the values in the user's TSO profile, will be in effect for the entire session or until changed on a subsequent screen.

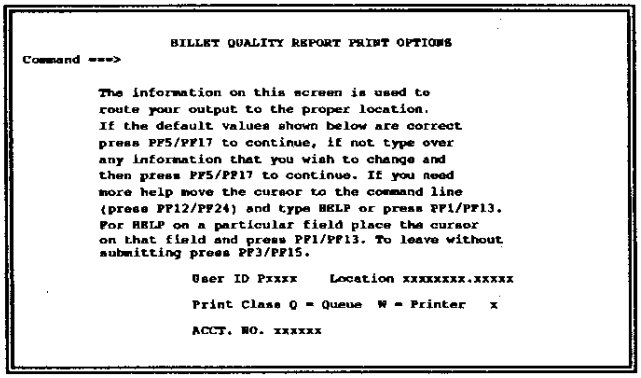


FIGURE 5. Buffer Screen

This screen is followed by the one shown in Figure 6. From this latter screen, the users can run any or all of the eight reports listed. However, if all eight reports were selected the output would be quite voluminous; therefore, we have provided several mechanisms for limiting the scope of the reports (e.g. classifying the grades into standard groups). Specific reports are selected by placing an X in front of the desired report number. If any of the first three reports are to run for a specific grade group, fill in the group number; otherwise, leaving 000 as the group number will generate the report for all appropriate groups. For a list of group numbers the user can position the cursor on the group field and press PF1. A list of the appropriate groups will be displayed.

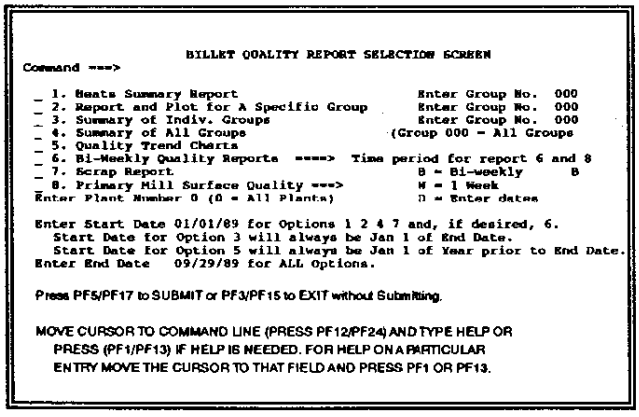


FIGURE 6. Report Option Screen

Whenever a job is submitted to generate any reports from Option 3 a banner page will be created and printed as the first part of the package of reports. It will show which reports were created, the date and time of creation and any limiting criteria such as plant, group and time period contained in the reports.

Report option 1 will generate a series of very detailed quality engineering reports (such as the one shown in the top portion of Figure 7) that list every heat processed grouped into standard grade groups. There are two distinct formats used for these reports depending on whether the billets from that group are normally sent to billet conditioning or used directly from the Primary Mill. The reports will print out 44 heats per page and will use as many pages as required. If only one specific group of billets and/or a specific time period is being studied, the report may be limited to that specific group and/or time period by entering the desired group number and/or dates in the indicated data entry fields. Help screens are available to aid in the selection of the group number.

Report option 2 is similar to option 1 except that it will also include Statistical Process Control ("SPC") charts such as the one shown in Figure 8 for every heat processed grouped into the standard grade groups. These SPC Shewhart charts are generated for three different flaw depths and the percentage of billets scrapped. This option will also generate two different kinds of tabular reports and, as in option 1, may be limited to a single group and/or time period by appropriate selection of the input options.

Report option 3 produces a one-page-per-grade-group report such as that shown in the middle portion of Figure 7 that summarizes the monthly, quarterly and yearly performance of all of the billets that are in that group. As with the previous two options, there are two distinct formats used for these reports depending on the billet conditioning requirements, and the report can be limited to a specific group by proper choice of the input options.

Report option 4, by contrast, also produces a summary report but, in this case, as shown in the bottom portion of Figure 7, we are summarizing the performance of every grade group on a single page-one page for the specified time period and/or one page for year to date.

Report option 5 is a departure from the previous four options that generate tabular quality engineering data, in that it generates management quality trend charts. As shown in Figure 9, the trend chart generated by this option contains three curves: one each for total scrap, rod mill scrap and primary mill scrap. The reporting period is determined from input options. The data from the previous year will be plotted on a quarterly basis while the data from the current year will be plotted on a monthly basis. This graph contains three curves showing percent defects at three quality levels for the overall production and for each functional subset of the data.

Report option 6 produces a management quality summary report for a specified time period which, by default, is generally biweekly. As shown in Figure 10, these reports present a composite summary of the quality for the specified reporting time period and compares that data with

REPORT RM1A 1

ROD MILL BILLET PERFORMANCE FOR GRADES THAT MUST ALWAYS BE CONDITIONED BEFORE ROLLING
ANALYSIS BASED ON PLANT NUMBER 3 HEATS TAPPED BETWEEN 01/01/88 AND 06/30/88
GRADE GROUP = INGT RIMMED CHQ

TAP DATE	HEAT NO.	GRADE	HOT BED BILLETS NO. ROLL	SCRAP NO.	SCRAP %	NO. SHIP	INITIAL MAGNAGLO INSPECTION TOTAL INSP.	SEAM > 030 NO.	SEAM > 030 %	SEAM > 060 NO.	SEAM > 060 %	SEAM > 090 NO.	SEAM > 090 %	SKIN GRNDS NO.	SKIN GRNDS %	MAGNAGLO REINSP. NO.	MAGNAGLO REINSP. %	TOTAL ROD MILL SCRAP NO.	TOTAL ROD MILL SCRAP %	TOTAL PRIME NO.	TOTAL PRIME %
01/20/88	402N810	D 99D	143	0	0	143	143	114	80	32	22	16	11	0	0	0	0	10	7	29	20
01/21/88	402N829	D 33D	153	0	0	153	153	127	83	33	22	13	8	5	3	0	0	12	8	26	17
02/04/88	....	..	..	..	.	..	..	..	..	..	..	..	.	.	.	.	.	..	.	..	..
02/06/88	....	..	..	..	.	..	..	..	..	..	..	..	.	.	.	.	.	..	.	..	..
		TOTAL	3149	36	1	3113	2811	2466	88	1057	38	505	18	182	6	0	0	126	4	813	29

REPORT RM3A 1

ROD MILL BILLET PERFORMANCE FOR GRADES THAT MUST ALWAYS BE CONDITIONED BEFORE ROLLING
ANALYSIS BASED ON PLANT NUMBER 3 HEATS TAPPED BETWEEN 01/01/88 AND 06/30/88
GRADE GROUP = INGT RIMMED CHQ

TIME PERIOD	NO. HTS.	HOT BED BILLETS NO. ROLL	SCRAP NO.	SCRAP %	NO. SHIP	INITIAL MAGNAGLO INSPECTION TOTAL INSP.	SEAM > 030 NO.	SEAM > 030 %	SEAM > 060 NO.	SEAM > 060 %	SEAM > 090 NO.	SEAM > 090 %	SKIN GRNDS NO.	SKIN GRNDS %	MAGNAGLO REINSP. NO.	MAGNAGLO REINSP. %	TOTAL ROD MILL SCRAP NO.	TOTAL ROD MILL SCRAP %	TOTAL PRIME NO.	TOTAL PRIME %
JANUARY	2	296	0	0	296	296	241	81	65	22	29	10	5	2	0	0	22	7	55	19
FEBRUARY	..	...	..	.	...	...	...	..	...	..	...	..	..	.	.	.	...	.	...	..
MARCH	..	...	..	.	...	...	...	..	...	..	...	..	..	.	.	.	...	.	...	..
1ST QTR.	13	1764	24	1	1740	1599	1398	87	656	41	344	22	98	6	0	0	106	7	420	26
2ND QTR.	9	1385	12	1	1373	1212	1068	88	401	33	161	13	84	7	0	0	20	2	393	32
YEAR TO DATE	22	3149	36	1	3113	2811	2466	88	1057	38	505	18	182	6	0	0	126	4	813	29

REPORT RM4A1 1

ROD MILL BILLET PERFORMANCE FOR GRADES THAT MUST ALWAYS BE CONDITIONED BEFORE ROLLING
ANALYSIS BASED ON PLANT NUMBER 3 HEATS TAPPED BETWEEN 01/01/88 AND 06/30/88

GRADE GROUPS	NO. HTS.	HOT BED BILLETS NO. ROLL	SCRAP NO.	SCRAP %	NO. SHIP	INITIAL MAGNAGLO INSPECTION TOTAL INSP.	SEAM > 030 NO.	SEAM > 030 %	SEAM > 060 NO.	SEAM > 060 %	SEAM > 090 NO.	SEAM > 090 %	SKIN GRNDS NO.	SKIN GRNDS %	MAGNAGLO REINSP. NO.	MAGNAGLO REINSP. %	TOTAL ROD MILL SCRAP NO.	TOTAL ROD MILL SCRAP %	TOTAL PRIME NO.	TOTAL PRIME %
INGT RIMMED CHQ	22	3149	36	1	3113	2811	2466	88	1057	37	505	18	182	7	0	0	126	4	813	29
INGT BORON CHQ	..	....	..	.	....	....	....	..	....	..	...	..	....	...	....	..	...	..	...	..
INGT BORON CHQ 1	..	....	..	.	....	....	....	..	....	..	...	..	....	...	....	..	...	..	...	..

FIGURE 7. Sample Heat History Reports from Options 1, 3 and 4

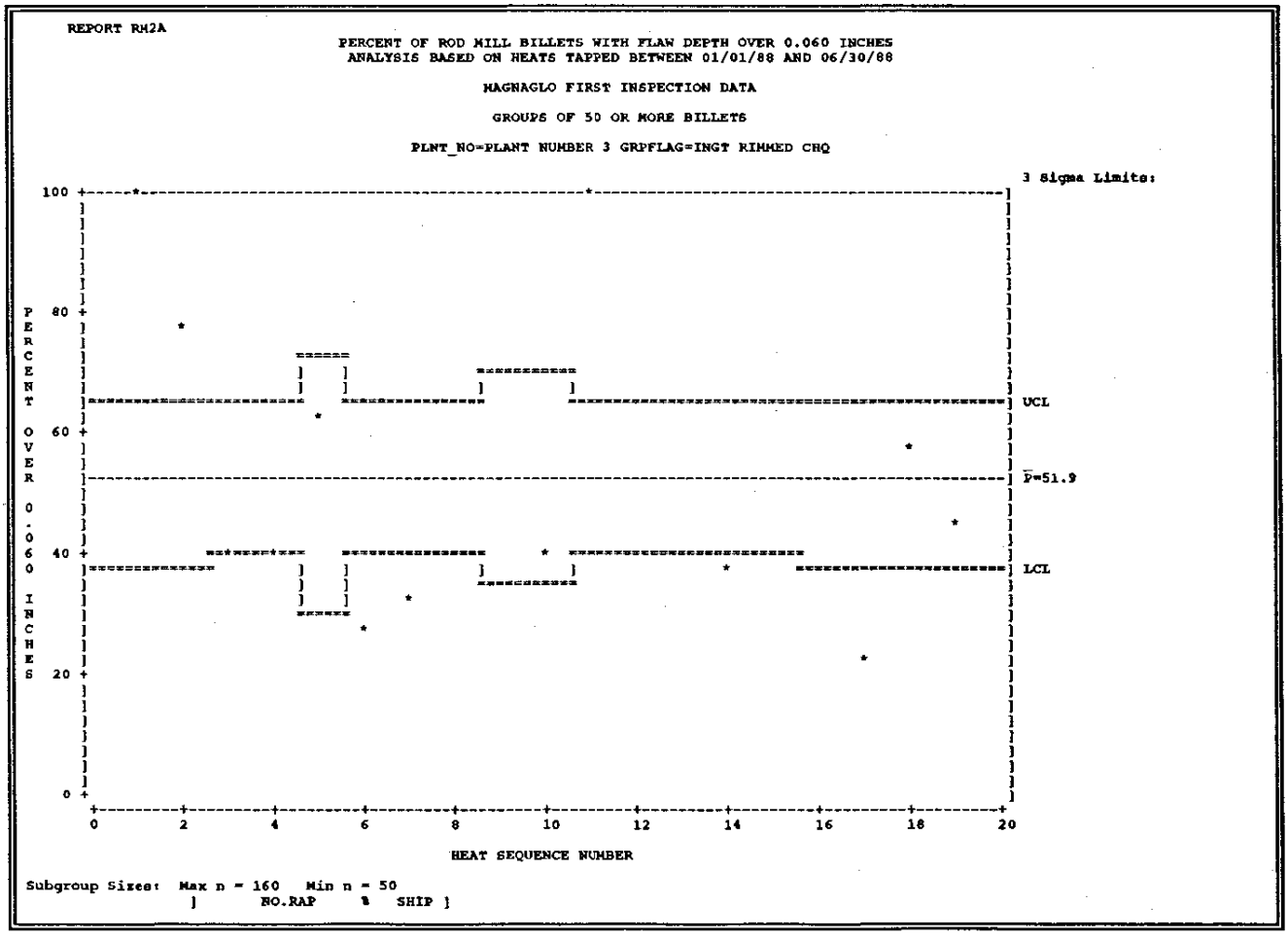
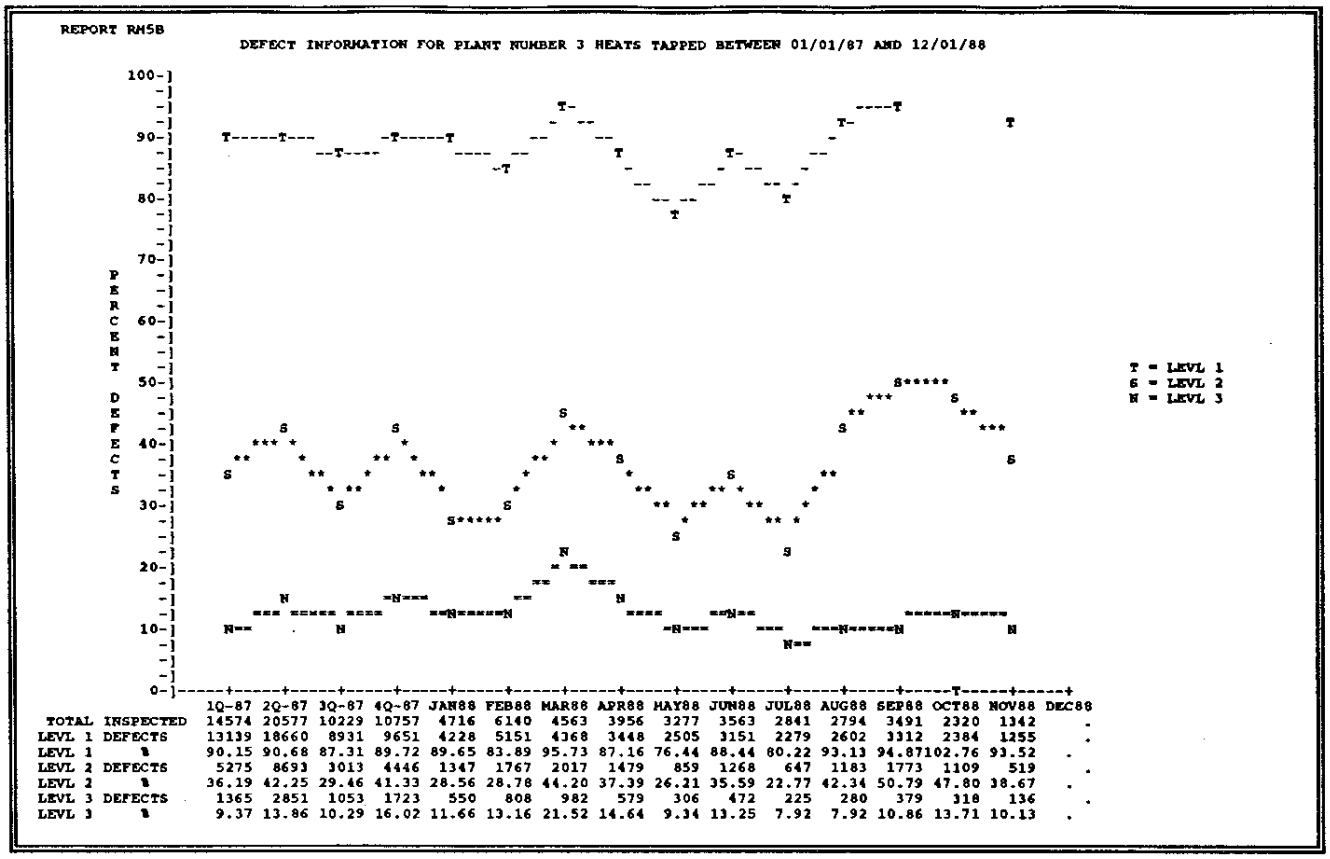


FIGURE 8. Sample SPC Shewhart Chart



	1Q-87	2Q-87	3Q-87	4Q-87	JAN88	FEB88	MAR88	APR88	MAY88	JUN88	JUL88	AUG88	SEP88	OCT88	NOV88	DEC88
TOTAL INSPECTED	14574	20577	10229	10757	4716	6140	4563	3956	3277	3563	2841	2794	3491	2320	1342	.
LEVL 1 DEFECTS	13139	18660	8931	9651	4228	5151	4368	3448	2505	3151	2279	2602	3312	2384	1255	.
LEVL 1 %	90.15	90.68	87.31	89.72	89.65	83.89	95.73	87.16	76.44	88.44	80.22	93.13	94.87	102.76	93.52	.
LEVL 2 DEFECTS	5275	8693	3013	4446	1347	1767	2017	1479	859	1268	647	1183	1773	1109	519	.
LEVL 2 %	36.19	42.25	29.46	41.33	28.56	28.78	44.20	37.39	26.21	35.59	22.77	42.34	50.79	47.80	38.67	.
LEVL 3 DEFECTS	1365	2851	1053	1723	550	808	982	579	306	472	225	280	379	318	136	.
LEVL 3 %	9.37	13.86	10.29	16.02	11.66	13.16	21.52	14.64	9.34	13.25	7.92	7.92	10.86	13.71	10.13	.

FIGURE 9. Sample Quality Trend Reports from Option 5

historical data. The upper portion of the chart shows monthly scrap as a percent of production while the middle portion of the chart shows individual defects as a percent of production for the year-to-date, and the lower portion of the chart shows individual defects as a percent of production for the indicated two-week time period. To conserve time we

REPORT RM6C — SUMMARY OF NON-CONFORMING TONNAGE
QUALITY STATISTICS - TOTAL PLANT NUMBER 3 BILLETS SCRAPPED

TIME PERIOD	- - - P E R C E N T O F P R O D U C T I O N - - - 0....+....1....+....2....+....3....+....4....+....5	SCRAP TONS	BILLET TONS	BILLET %	INGOT TONS	INGOT %
YEAR 1987	********** | ****** 87 GOAL = 2.40	9617	306966	3.13	406634	2.37
YEAR 1988	********** | 88 GOAL = 2.40	5264	307682	1.71	390695	1.35
1ST QTR 1988	********** |	1783	86267	2.07	105645	1.69
2ND QTR 1988	********** |	1276	83397	1.53	107456	1.19
3RD QTR 1988	********** |	1044	68191	1.53	87849	1.19
4TH QTR 1988	********** |	1155	69827	1.65	89745	1.29
OCTOBER 1988	********** |	406	25922	1.57	33499	1.21
NOVEMBER 1988	********** |	338	24753	1.37	31880	1.06
DECEMBER 1988	********** |	411	19152	2.15	24366	1.69
1989 TO DATE	**********	4550	169359	2.69	214699	2.12
JANUARY 1989	**********	645	24936	2.59	31568	2.04
FEBRAURY 1989	**********	768	20678	3.71	26381	2.91
MARCH 1989	**********	743	25310	2.93	31895	2.33
APRIL 1989	**********	615	23835	2.58	29896	2.06
MAY 1989	**********	623	25854	2.41	32732	1.90
JUNE 1989	**********	762	28505	2.67	36277	2.10
JULY 1989	**********	395	20243	1.95	25948	1.52
AUGUST 1989	*					
SEPTEMBER 1989	*					
OCTOBER 1989	*					
NOVEMBER 1989	*					
DECEMBER 1989	*					
16JUL89-29JUL89	**********	186	10170	1.83	13091	1.42

TIME PERIOD: 16JUL89-29JUL89

DEFECT	- - - P E R C E N T O F P R O D U C T I O N - - - 0....+....1....+....2....+....3....+....4....+....5	% NON-CONFORMING	CUM % NON-CONFORMING	% RELATIVE
SCABS	**********	1.06	1.06	58.06
SEAMS	*****	0.44	1.50	24.19
CHEMICAL ANALYSIS	*	0.09	1.59	4.84
BENT	*	0.07	1.67	4.03
LAPS	*	0.04	1.71	2.42
SHORT	*	0.04	1.76	2.42
TWIST	*	0.04	1.80	2.42
BROKEN EDGE/SURFACE	*	0.01	1.81	0.81
CORNER CRACKS	*	0.01	1.83	0.81

FIGURE 10. Sample Bi-Weekly Quality Reports from Option 6

have limited the example to just the top and bottom reports. Separate charts are generated for all scrapped billets: the billets scrapped at the Primary Mill and the billets scrapped at the Rod Mill.

Report option 7 produces a two page summary of the billets that were scrapped in the specified time period. As shown in the top half of Figure 11, the first page summarizes the total number of billets scrapped by category while the second page (bottom half of Figure 11) summarizes the scrapped billets by heat, grade and the reasons for scrapping them. This report serves as the vehicle for requesting reimbursement for defective material.

Report option 8 is a two-part summary of primary billet surface quality data for all billets produced within the specified time period which, by default, is generally weekly. The first part of this report, shown in the top half of Figure 12, is a listing of the data for every heat produced and is summarized by day and production method (i.e. ingot or caster). The second part of the report (bottom of Figure 12) is a daily summary of the quality and production data.

Data Entry/Validation/Updating Options

As discussed above, these options are restricted to a small number of specifically authorized and trained users. Figure

REPORT RM7A
BILLET CONDITIONING — PLANT NUMBER 3
BILLETS — WEEK ENDING 06/30/88

PLANT NUMBER 3

142	GROUP NO. 1
205	GROUP NO. 2
9	GROUP NO. 3
107	GROUP NO. 4
57	GROUP NO. 5
252	GROUP NO. 7
105	GROUP NO. 8
877	TOTAL

BILLETS SCRAPPED BETWEEN 01/01/88 & 06/30/88
REPORT RM7B — PLANT NUMBER 3 HEATS

DATE	TURN	CODE	HEAT NUMBER	GRADE	BRKN EDGE	SCAB	SEAM	CRN. CRKS	PIPE	FISH INSF DISC	LAPS	BENT	TWST	OVER FILL	ORDR SCRP	BERO	MIXD STL.	CHEM ANAL	SHRT	OTHR	TOTAL CATEGORY
01/21/88	2	YD	411T750	NB65K	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 7
01/21/88	2	YD	411T750	NB65K	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3 7
01/21/88	2	M1	421T105	R 34A	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7 1
01/21/88	2	YD	422T159	W 92M	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 8
01/22/88	.	..	.....	.....	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	. .
01/22/88	.	..	.....	.....	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	. .
01/22/88	.	..	.....	.....	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	. .

FIGURE 11. Sample Scrap Reports from Option 7

PRIMART MILL BILLET SURFACE QUALITT DATA — 12:14 WEDNESDAY, MARCH 28, 1990 1
FOR THE PERIOD 18FEB90 THRU 24FEB90

HEAT NUMBER	GRADE	NO. OF BILLETS	SLAB/ INGOT TONS	BRKN EDGE	SCAB	SEAM	CRN. CRKS	PIPE	FISH INSF DISC	LAPS	BENT	TWST	OVER FILL	ORDR SCRP	BERO	MIXD STL.	CHEM ANAL	SHRT	OTHR	TOTAL SCRAP
WEEKNO=8 ROLLDATE=19FEB90 TYPE=CASTER																				
401W067	QB79E	176	289.014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WEEKNO=8 ROLLDATE=19FEB90 TYPE=INGOT																				
411W006	PN99Y	128	297.12	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
412W202	W 35M	90	172.05	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	6
412W209	W 39M	140	267.95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
412W211	WA78M	90	173.66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
412W213	W 92M	133	256.59	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
412W228	PN61Y	150	297.32	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5
TYPE		731	1464.70	0	1	0	0	0	0	0	0	12	0	0	0	0	0	0	0	13
ROLLDATE		907	1753.71	0	1	0	0	0	0	0	0	12	0	0	0	0	0	0	0	13

DAILY BILLET ACTIVITY — 12:14 WEDNESDAY, MARCH 28, 1990 4

OBS	DATE	CASTER BILLETS PRODUCED	CASTER BILLETS SCRAPPED	INGOT BILLETS PRODUCED	INGOT BILLETS SCRAPPED	TOTAL BILLETS PRODUCED	TOTAL BILLETS SCRAPPED
1	18FEB90	0	0	732	5	732	5
2	19FEB90	176	0	731	13	907	13
3	20FEB90	96	0	666	9	762	9
4	21FEB90	0	0	0	0	0	0
5	22FEB90	256	0	497	5	753	5
6	23FEB90	0	0	732	9	732	9
7	24FEB90	103	0	703	3	806	3
		631	0	4061	44	4692	44

FIGURE 12. Sample Billet Rolling Mill Reports from Option 8

13 is a flow chart showing the general organization of these three related options. As discussed above, because all of the data are entered from handwritten reports generated by a number of different people, they are first read into a temporary file and are validated before being added to the system's performance summary files.

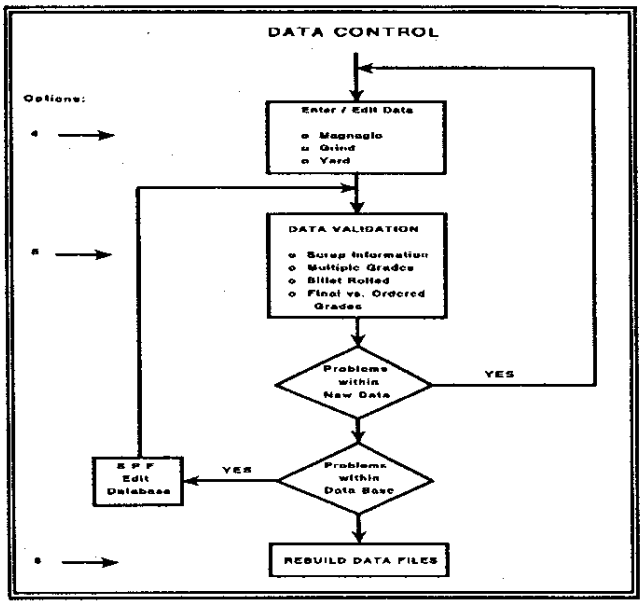


FIGURE 13. Data Entry/Validation/Update Functions

SYSTEM OPTION 4 - Data Entry

There are three different kinds of data entry screens required to cover the three different types of operations (conditioning, inspection and acceptance) accessed through Option 4 (Ref. Figure 4) and all three of them were written in SAS/FSP. The data files may be browsed or edited using the selection screen shown in Figure 14. All three of the data entry screens were formatted to closely resemble the printed forms that had previously been used for manual reporting purposes. As an example, Figure 15 shows the input screen for the grinder billet conditioning area. These screens save the data as files that are in the form of three SAS permanent data sets so that the data can be validated before being added to the system's performance summary files.

```
                    ROD MILL DATA ENTRY and EDIT SCREEN
Command ===>

                    Select Option

                    _ 1. Browse Data in Transaction Files

                    _ 2. Enter or Edit Data

                    Select Data Type

                    _ 1. Grind Data

                    _ 2. Magnaglo Data

                    _ 3. Yard Data

        Press PF5 or PF17 to Submit.
        Press PF3 or PF15 to Exit without Submitting.

  Move Cursor to Command Line (Press PF12/PF24) and type HELP or Press
    (PF1/PF13) if help is needed. For help on a particular field move
     the cursor to that field and press (PF1/PF13).
```

FIGURE 14. Data Entry Option Screen

```
Command ===>          Edit SAS data set: BTHIST.GRIND          Screen  1
                                                                Obs     4

                          GRIND DATA

        Process Date: 102888      Turn: 1
              Htno: 411P603   Grade: X 15N    Category: 1

          BILLETS:  4        PRIME:  4     RE-GRIND:  0
             SKIN:  0        SCRAP:  0

                      Reasons for Scrapping:

Broken edge/surface      A: __    Twist                J: __
Scabs                    B: __    Overfill             K: __
Seams                    C: __    Order scrap          L: __
Corner cracks            D: __    B.E.R.O.             M: __
Pipe                     E: __    Mixed steel          N: __
Fishtail/insf. dscd.     F: __    Chemical analysis    R: __
Laps                     G: __    Short                S: __
Bent                     H: __    Other                X: __
```

FIGURE 15. Sample Data Entry Screen

SYSTEM OPTION 5 - Generate Exception Reports

As with option 4, this option is also restricted to authorized users and, although it is shown in Figure 4, it will not even appear on the option screen seen by the general user community. Its function is to identify questionable data and generate an exception report that suggests corrective action. For example, it checks that valid reasons are provided for every scrapped billet and that the heat number and grades are valid. It also checks previous entries for each heat to determine if more than one grade had been specified or if more billets had been processed that had been produced. Any errors identified in these reports must be corrected before the data are used to update the database.

SYSTEM OPTION 6 - Database Builder

This option is also restricted to authorized users and serves to update the four system data summary files. An update request confirmation screen is included to avoid inadvertent updating of the files.

SUMMARY

The Rod Mill Billet Surface Quality Reporting System, which is written in SAS/AF, was designed to include data entry, data validation and report generation functions in one user-friendly, menu-driven system. The system uses formatted SAS/FSP screens to simplify data entry by emulating the arrangement of data on the existing production reports. All data are initially stored in transaction data files for validation and correction of any errors before they are added to the history and summary data files. Data validation is done at both data entry time and through use of a user-controlled validation program. At key entry time, all pertinent tests available in SAS/FSP (minimum, maximum, character/numeric and required fields) are used to assure that the data are reasonable before they are even added to the transaction file. A diagnostic program is then used to compare the new data with information in the production data files to detect inconsistent or erroneous data. Eight different kinds of standard reports are included which range from detailed quality engineering reports through successive levels of increasingly summarized management information reports. In addition, all data are maintained in a series of formatted files to facilitate ad hoc inquiries.