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THE MAGNET COMPONENTS DATABASE SYSTEM*

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ABSTRACT

The philosophy, structure, and usage of MagCom, the SSC magnet components database, are described. The database has been implemented in Sybase (a powerful relational database management system) on a UNIX-based workstation at the Superconducting Super Collider Laboratory (SSCL); magnet project collaborators can access the database via network connections. The database was designed to contain the specifications and measured values of important properties for major materials, plus configuration information (specifying which individual items were used in each cable, coil, and magnet) and the test results on completed magnets. These data will facilitate the tracking and control of the production process as well as the correlation of magnet performance with the properties of its constituents.

PURPOSE

From the earliest R&D days of the SSC project, the magnet test groups at the labs have recognized the need for a complete and up-to-date database of configuration and test data pertaining to the components of the magnets. Such a database would enable magnet scientists to correlate performance properties of any magnet with its structural raw materials.

For instance, magnet testers predict the likely magnet quench currents from the short sample measurements on the cable. Magnet designers compare the measured field with properties of the cable and coil assembly. In an operating environment, the accelerator controls system will need to know the performance features of each individual magnet and relate these to its lattice location.

The Magnet Components (MagCom) database is intended to serve these scientific needs. Its design includes some aspects of purchase tracking, quality

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control, and configuration control, so that scientists know the serial numbers for the major components of each magnet, the vendors that supplied the materials, and references to the backup quality assurance tests and documents. However, MagCom does not eliminate the need for complete bill of materials and purchase tracking systems. Ultimately it should have access to such tracking information by direct links to databases maintained by appropriate groups.

The goal for the MagCom database is to have all magnet data, spanning all phases of construction and testing, accessible from a central, user-friendly system. This system should allow both quick access to summary data of broad interest and retrieval of detail data for in-depth studies.

SOFTWARE & HARDWARE

The MagCom database is implemented using the SYBASE relational database management system (RDBMS) in a UNIX environment on a SUN 4/280 server which is connected to Internet and DecNet. It can be accessed via SUN workstations or vt100-type terminals. Some introductory documentation and copies of general reports are also available on the SSC central VAX computer. (See Figure 1)

SYBASE was selected as the vehicle for SSC scientific databases in December 1987 by an SSC Central Design Group (SSC/CDG) task force.¹ Initial experience, including development of a general data export system and graphics utilities, was concentrated in the accelerator controls area.² From the beginning, it was considered essential to have a "hub and spoke" data organization, with a central database to specify the interrelationship of databases maintained by various groups. (See Figure 2.)

DATABASE STRUCTURE

A relational database consists of independent tables with specific column names and unlimited rows for data. For useful retrievals, a table should have one or more key columns that provide a unique identifier for each row. These key columns also allow data from different tables to be related when they have the same key values. This provides the power and flexibility in a relational database system.

The first pass at specifying the desired contents of a magnet components database was made by a "commission on cable data" that was appointed by Tom Kirk, the head of the SSC/CDG Magnet Division, in fall 1988. The commission included representatives from all the laboratories involved in SSC magnet R&D.³

The commission quickly recognized that although wire and cable test data were the items of prime interest initially, they were only part of the data needed for a full study of the magnets. The proposed database contains tables in eleven general sections, spanning the magnet building cycle from specifications on major materials through performance measurements on magnets. (See Figure 3)

IMPLEMENTATION & CURRENT STATUS

Going from design to a functioning database operation involved work on several fronts. In the first phase, a program was developed that automatically

ACCESS INFORMATION FOR MAGNET COMPONENTS (MAGCOM) DATABASE

Information and Current Summary Reports

DecNet: SSCVX1::User 2:(MagCom)

Database

Internet: grumpy.ssc.gov 134.3.10.10
DecNet: SSCSUN 41.375
Server: SUN 4/280 with SYBASE 4.0
Public Account: mdbuser
Access Command: magcom

E-Mail for MagCom Staff

Bitnet: MagCom @ SSCVX1
DecNet: SSCVX1::MagCom
Internet: magcom @ sscvx1.ssc.gov

Figure 1. Database Access

Figure 2. Hub and Spoke

MAJOR TABLE CATEGORIES FOR SSC MAGNET COMPONENTS DATABASE

1. Vendor, purchasing, and general information
2. Specifications for strand and cable
3. Ingot and billet production and tests; strand production and receiving
4. Strand tests
5. Cable production and receiving
6. Cable tests
7. Coil information
8. Cold mass assembly information
9. Cryostat assembly
10. Magnet data
11. Comments on tables; gossip; formats and naming conventions

Figure 3. Major table categories for SSC Magnet Components Database

produced all the SYBASE table creation commands from the design document text file. Cable measurement data and magnet configuration information were obtained from Lawrence Berkeley Laboratory (LBL) and Brookhaven National Laboratory (BNL) collaborators via ASCII files, and a summary report of cable properties by magnet was created. (See Figure 4.)

Later, import/export utilities were developed to convert tables between SYBASE format and the formats for the PC database systems of R:BASE or dBASE, which are in use by the BNL and LBL groups. Recently, a SSCL Magnet Systems Division quality assurance engineer has developed a dBASE application that will be run on a portable computer for collection of cable production data at the cabling site.

The MagCom staff works with the staff of the engineering groups to identify the prime data that should be available to the full project and to set up the procedures for collecting and reporting that data in a timely way. The initial focus has been on summary data of broad interest with references to further sources (paper or computer files) for backup details.

Summary and detail reports have been written for the items of general interest, and a menu program that runs directly from UNIX allows user-friendly access to these reports. After logging in to the UNIX system, the user simply types the word "magcom" and then follows the directions. All reports offer the option of being displayed on the screen or written to a file for printing.

Mar 20 1990 Magnet Cable Data Summary2 01										* - denotes new data									
MAGNET ID-0010	CABLE SO-0080	Cu/SC 1.65	Electrical Measurements (at 22K)					Resistivity					Magnetization						
			amps JC(5T) 2672	amps JC(5T) 9,970	amps JC(5T) 2346	amps JC(5T) 8,757	amps JC(5T) 8,757	uOhm/cm R295K 28.7	ratio RRR 70	ratio RRR 70	ratio RRR 70	ratio RRR 70	MT/sec ramp 21.0	MT/sec ramp 21.0	MT/sec ramp 21.0	MT/sec ramp 21.0	MT/sec ramp 21.0	MT/sec ramp 21.0	MT/sec ramp 21.0
DD-0011	SI-0052	1.19	2686	14,430	7.0	1627	8,740	27.2	0.20	136	20.5	0.30	21.4	1.3					
	SO-0087	1.64	2639	9,890	5.6	2317	8,689	28.8	0.43	67	21.0	0.30	19.2	2.0					
DD-0012	SI-0054	1.57	2337	10,730	7.0	1420	6,530	24.5	0.31	79	21.0	0.30	23.6	1.0					
	SI-0055	1.80	2380	10,790	7.0	1447	6,560	24.3	0.31	78	21.0	0.30	24.4	1.0					
	SO-0098	1.65	2565	9,570	5.6	2248	8,387	20.5	0.21	135	21.0	0.30	20.4	3.7					
	SO-0099	1.67	2576	9,550	5.6	2257	8,367	20.5	0.21	135	21.0	0.30	21.1	3.6					
DD-0013	SI-0063	1.49	2700	12,789	7.0	1576	7,463	25.1	0.40	63	21.0	0.30	19.8	1.8					
	SO-0102	1.59	2508	9,230	5.6	2198	8,079	28.3	0.25	113	21.0	0.30	18.9	3.4					
	SO-0103	1.69	2511	9,230	5.6	2201	8,089	28.3	0.25	113	21.0	0.30	19.7	3.6					
DD-0014	SI-0059	1.24	2541	13,380	7.0	1502	7,910	26.8	0.24	112	21.0	0.30	26.6	3.1					
	SO-0104	1.68	2524	9,300	5.6	2211	8,147	28.3	0.21	135	21.0	0.30	19.7						
DD-0015	SI-0060	1.24	2551	13,440	7.0	1508	7,940	26.8	0.23	117	21.0	0.30	27.1						
	SI-0058	1.44	2651	13,980	7.0	1567	8,260	26.8	0.22	122	21.0	0.30	27.0	2.8					
	SO-0074	1.80	2446	8,615	5.6	2143	7,549	27.9	0.50	56	20.8	0.30	13.9	9.9					
	SO-0105	1.65	2515	9,370	5.6	2202	8,211	28.5	0.22	130	21.0	0.30	18.7	3.7					
DD-0016	SI-0064	1.37	2775	13,285	7.0	1619	7,741	25.2	0.40	63		0.30	20.7	1.3					
	SI-0065	1.47	2780	13,807	7.0	1548	7,684	25.8	0.36	72		0.30	21.0	1.8					
	SO-0122	1.65	2453	9,154	5.6	2159	8,064	28.7	0.3	74	21.0	0.30	16.3	2.0					
DD-0017	SC11-0394	1.59	2823	12,848	7.0	1662	7,562	24.4	0.35	70	21.0	0.30	26.6	2.6					
	SC32-0391	1.72	2435	8,860	5.6	2135	7,770	28.3	0.41	69		0.30							
	SC32-0001	1.64	2467	9,321	5.6	2171	8,203	28.9	0.40	72	21.0	0.30	14.4	1.3					
DD-0018	SC11-0398	1.42	2730	13,284	7.0	1506	7,718	23.5	0.37	69	21.0	0.30	20.4	2.4					
	SC21-0396	1.69	2422	8,910	5.6	2132	7,841	28.5	0.44	65		0.30							
DD-0019	SC12-00001	1.44	2499	12,076	7.0	1545	7,465	25.7	0.73	35		0.30							
	SC12-00001	1.44	2591	12,515	7.0	1602	7,736	25.3	0.34	74		0.30							
	SC12-00005	1.44	2512	12,137	7.0	1533	7,407	25.7	0.73	35		0.30							
	SC22-00004	1.75	2646	9,516	5.6	2318	8,337	28.6	0.49	58		0.30							
DD-0026	SC12-00001	1.44	2499	12,076	7.0	1545	7,465	25.7	0.73	35		0.30							
	SC12-00001	1.44	2591	12,515	7.0	1602	7,736	25.3	0.34	74		0.30							
	SC32-00004	1.75	2646	9,516	5.6	2318	8,337	28.6	0.49	58		0.30							
	SC32-00005	1.75	2715	9,770	5.6	2386	8,586	28.6	0.48	60		0.30							
	SC22-00005	1.76	2747	9,829	5.6	2412	8,630	28.5	0.47	61		0.30							

Figure 4. Magnet cable data summary report.

Figure 5. Magnet components database menu

The menu program allows retrieval of full detail data for one specified item (such as a cable, coil, or magnet) or summary data for a group of items starting from a specified ID. Figures 5 through 10 show the menu, several versions of configuration reports, and sample summary and detail reports. At present, the data is still limited to the cable measurement and magnet configuration tables.

Over the course of the past year, the ID schemes for cable, wire, and magnets have been revised, based on experience. Descriptions of the current schemes are available in the online documentation files. Also, the structure and contents of various tables have been changed. For instance, the cable measurement data tables were changed to a paired master and detail design to better reflect the structure of the data.

FUTURE PLANS

So far, all requests for data retrievals have been handled by members of the MagCom staff because the system has been undergoing development. However, the basic user features are now in place and the database will be available to the SSCL engineers to run their own retrievals if they wish.

The data collection will be expanded to new areas, beginning with summaries of quench and multipole results from magnet testing.

MAGNET -> COIL -> CABLE SUMMARY		
MAGNET	COIL	CABLE
DD-0018	LLNI-28	SC11-0398
	LLNI-29	SC11-0398
	LLNO-27	SC21-0396
	LLNO-28	SC21-0396
DD-0019	DDI-31	SC12-00001
	DDI-32	SC12-00005
	DDO-30	SC22-00004
	DDO-31	SC22-00004
DD-0026	DDI-30	SC12-00001
	DDI-34	SC12-00001
	DDO-32	SC22-00004
	DDO-33	SC22-00005
DD-0027	DDI-35	SC12-00007
	DDI-36	SC12-00007
	DDO-34	SC22-00005
	DDO-35	SC22-00005
DSS-001	DSSI-03	SI-0044
	DSSI-04	SI-0044
	DSSO-03	SO-0070
	DSSO-04	SO-0070
DSS-002	DSSI-05	SI-0047
	DSSI-06	SI-0047
	DSSO-01	SO-0070
	DSSO-02	SO-0070

Figure 6. Magnet configuration summary report

CONFIGURATION FOR		
MAGNET DD-0027		
	COIL	CABLE
INNER: (UPPER)	DDI-35	SC12-00007
INNER: (LOWER)	DDI-36	SC12-00007
OUTER: (UPPER)	DDO-34	SC22-00005
OUTER: (LOWER)	DDO-35	SC22-00005

Figure 7. Magnet configuration detail report

MAGNET ID
DD-0027

COIL INFORMATION

LOCATION: INNER

COIL ID: DDI-35

UPPER

CABLE SPOOL: SC12-00007

CABLE INFORMATION

CABLE SPOOL: SC12-00007

RUN #: 2318

VENDOR: SCN

RUN DATE: May 15 1989

B FIELD (tesla)	Ic (ampe)	Jc (ampe/mm2)	R295 (uOhm/cm)	R10	RFR	Cu/Sc
5.00	13037	2740	25.40	0.66	38	1.48
5.60	11473	2411				
6.00	10430	2192				
7.00	7822	1644				

No obvious surface damage as seen in coil conductor. No wire samples supplied. SCN Billet 2300-1

COIL INFORMATION

LOCATION: INNER

COIL ID: DDI-36

LOWER

CABLE SPOOL: SC12-00007

CABLE INFORMATION

CABLE SPOOL: SC12-00007

RUN #: 2318

VENDOR: SCN

RUN DATE: May 15 1989

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Figure 8. Magnet coil and cable detail report

CABLE ELECTRICAL DATA SUMMARY										
CABLE SPOOL	CABLE SEGMENT	RUN #	RUN DATE	R(295) uOhm/cm	R(10) uOhm/cm	RFR	Cu/Sc	B(T)	Ic amps	Jc amps/mm2
SC12-00005		2247	Mar 3 1989	25.70	0.73	35	1.44	5.00	12137	2512
								5.60	10718	2218
								6.00	9772	2022
								7.00	7407	1533
SCN 6 um. Front. Use same I5/I6 as 12-00004.										
SC12-00006	END	2264	Mar 10 1989	24.70	0.70	35	1.60	5.00	10938	2411
								5.60	9659	2129
								6.00	8806	1941
								7.00	6675	1471
SCN cable - Back. 6 um.										
SC12-00007		2318	May 15 1989	25.40	0.66	38	1.48	5.00	13037	2740
								5.60	11473	2411
								6.00	10430	2192
								7.00	7822	1644
No obvious surface damage as seen in coil conductor. No wire samples supplied. SCN Billet 2300-1										
SC12-0001		2071	Oct 31 1988	26.90	0.42	64	1.25	5.00	12156	2320
								5.60	10726	2047
								6.00	9772	1865
								7.00	7388	1410
SCN 364E-2, 6um fils.										
SC13-00001		2185	Jan 23 1989	25.40	0.33	77	1.43	5.00	13281	2733
								5.60	11687	2405
								6.00	10625	2187
								7.00	7968	1640
IGC 5275-1009, 6 um. NO WIRES: ASSUME I5/I6=1.25										
		2434	Nov 29 1989	25.30	0.33	77	1.45	5.00	13235	2746
								5.60	11617	2410
								6.00	10538	2186
								7.00	7840	1627
IGC 5275-1009. Rerun of R2185. Old pgs. included.										

Figure 9. Cable electrical data summary report.

CABLE ELECTRICAL DATA					
CABLE SPOOL: SC12-00007			VENDOR: SCN		
RUN #: 2318		RUN DATE: May 15 1989			
Measurement Data:	B(T)	T (deg K)	It (amps)	Iq (amps)	n
	5.37	4.36	11496	12198	28
	5.38	4.36	11584	12198	33
	5.79	4.40	10194	10832	26
		4.40	10202	10832	27
	6.15	4.42	9097	9779	25
		4.42	9218	9779	32
Summary Data:	R295 (uohm/cm)	R10	RRR	CU/SC	
	25.40	0.66	38	1.48	
	B(T)	Ic (amps)	Jc (amps/mm2)		
	5.00	13037	2740		
	5.60	11473	2411		
	6.00	10430	2192		
	7.00	7822	1644		
PROCEDURE DOCUMENT:			REVISION:		
No obvious surface damage as seen in coil conductor. No wire samples supplied. SCN Billet 2300-1					

Figure 10. Cable electrical data detail report.

REFERENCES:

1. R. Leedy, S. Peggs, C. Saltmarsh, L. Schachinger, R. Talman, T. Toohig, J. Tompkins, "Report of the Database Definition Task Force", SSC/CDG unpublished report, December 7, 1987
2. E. Barr, S. Peggs, and C. Saltmarsh, "Relational Databases for SSC Design and Control", SSC-N-606; to be published in Proceedings of the Particle Accelerator Conference, Chicago, March 1989.
3. M.J. Baggett, B.C. Brown, J. Carson, T. Ferbel, R. Leedy, R.M. Scanlan, R.H. Remsbottom and P. Wanderer, "General Remarks on the Organization and Contents of the Proposed Cable Data Base", SSC-N-582, Rev.No.1, March 24, 1989

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