SDC Cost / Schedule Overview
Superconducting Solenoid & Cryogenics
WBS 4.1 and 4.2

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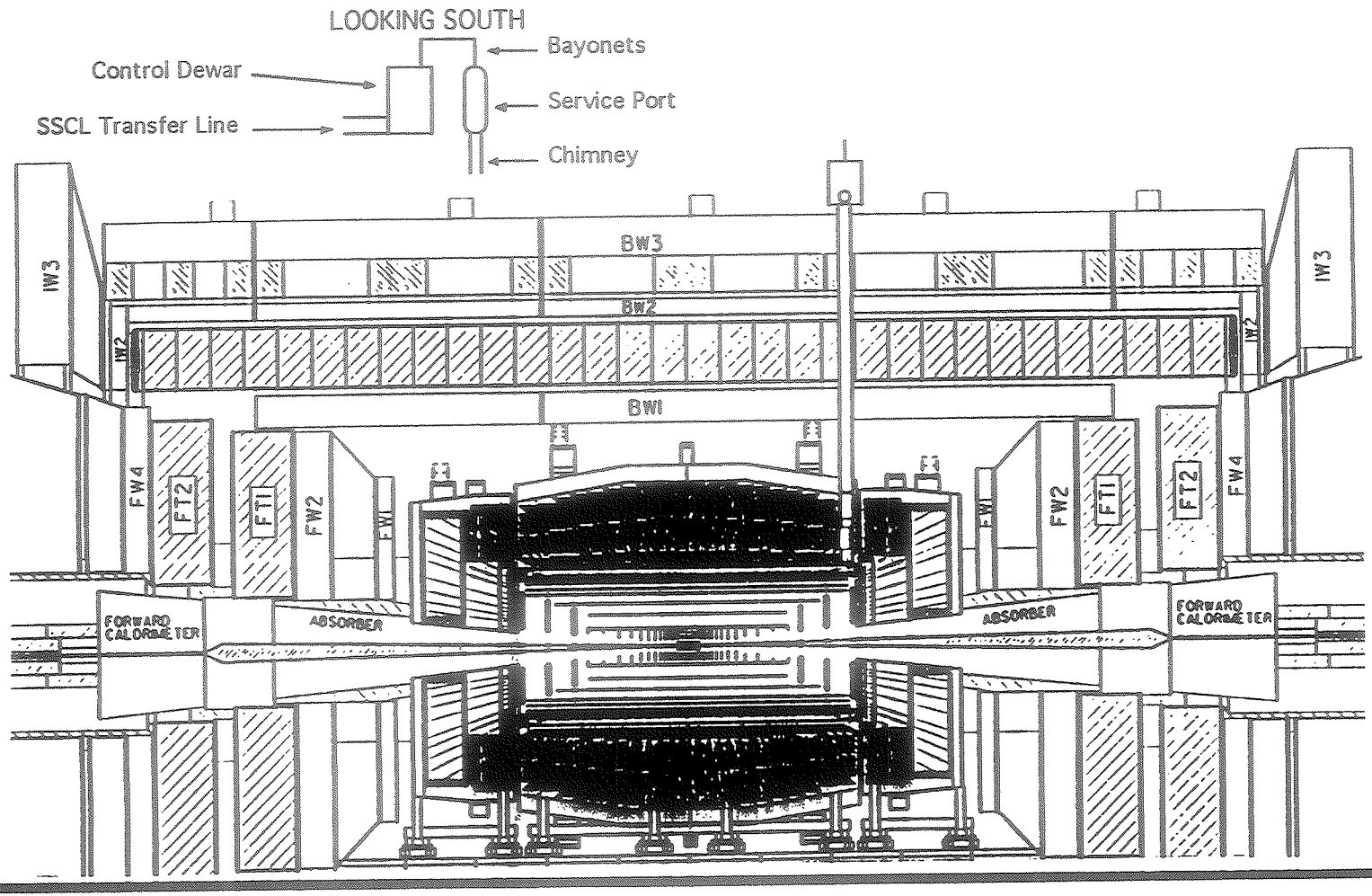
Rich also presented some of these viewgraphs to the Superconducting Magnet PAC Subpanel on May 6th (originally scheduled for May 5th). AMS

SDC SOLENOID SYSTEM

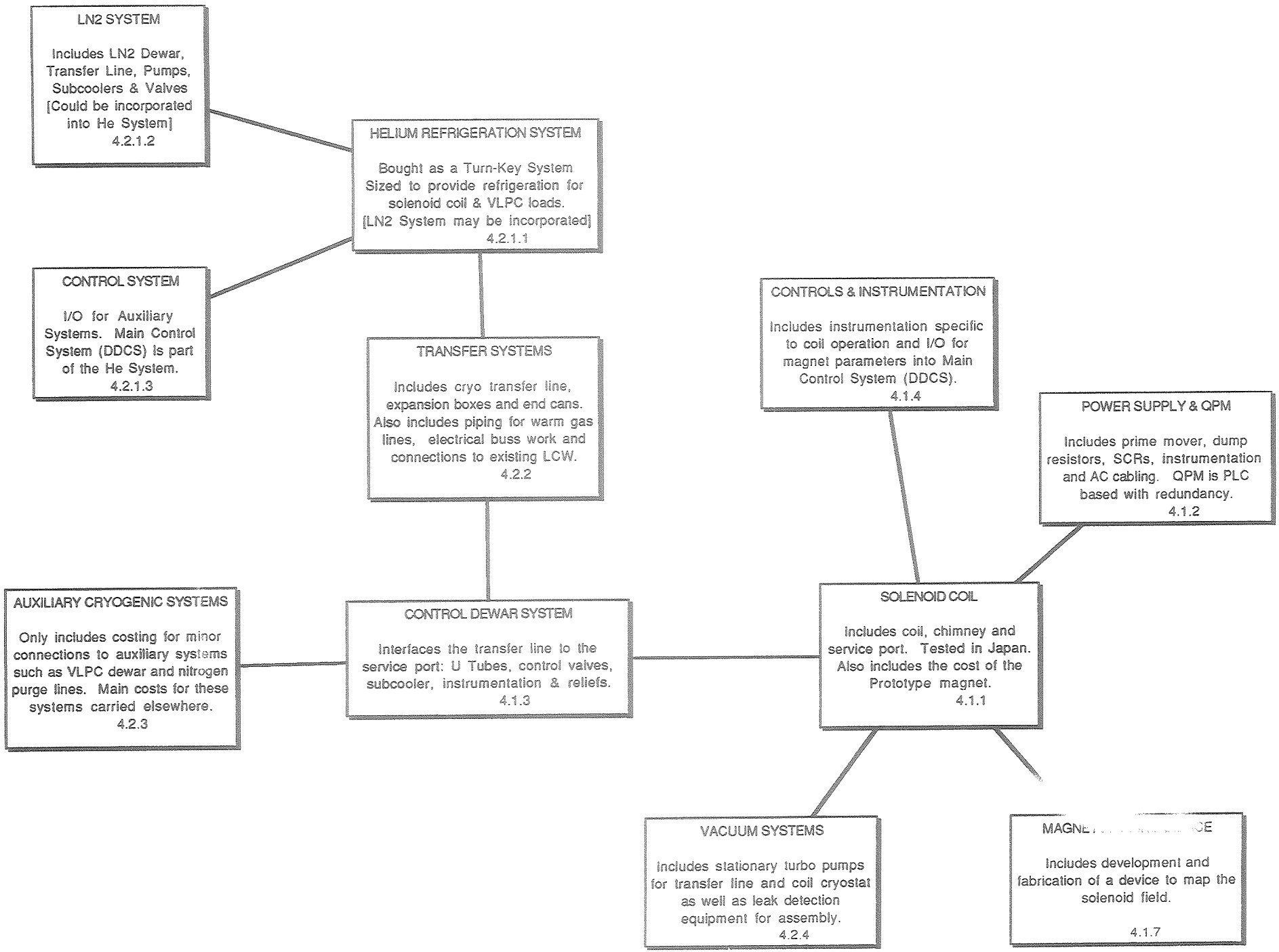
LOCATION OF COMPONENTS



SDC SOLENOID SYSTEM

Table 5-2
Baseline design parameters of SDC solenoid.

Dimensions:		
Cryostat	Inner radius	1.70 m
	Outer radius	2.05 m
	Half length	4.389 m
Coil	Effective radius	1.84 m
	Half length	4.12–4.18 m
Conductor	Thickness	44 mm
Outer support cylinder	Thickness	31 mm
Electrical parameters		
Central field		2.0 T
Nominal current		8,000 A
Inductance		4.6 H
Stored energy		146 MJ
Stored energy / cold mass		7.4 kJ/kg
Typical charging time		1 hour
Mechanical parameters		
Effective cold mass		20 tonnes
Total weight		25 tonnes
Radial magnetic pressure		1.6 MN/m^2
Axial compressive force		11 MN


LN2 SYSTEM
Includes LN2 Dewar, Transfer Line, Pumps, Subcoolers & Valves [Could be incorporated into He System]
4.2.1.2
HELIUM REFRIGERATION SYSTEM
Bought as a Turn-Key System Sized to provide refrigeration for solenoid coil & VLPC loads. [LN2 System may be incorporated]
4.2.1.1
CONTROL SYSTEM
I/O for Auxiliary Systems. Main Control System (DDCS) is part of the He System.
4.2.1.3
TRANSFER SYSTEMS
Includes cryo transfer line, expansion boxes and end cans. Also includes piping for warm gas lines, electrical buss work and connections to existing LCW.
4.2.2
CONTROLS & INSTRUMENTATION
Includes instrumentation specific to coil operation and I/O for magnet parameters into Main Control System (DDCS).
4.1.4
POWER SUPPLY & QPM
Includes prime mover, dump resistors, SCRs, instrumentation and AC cabling. QPM is PLC based with redundancy.
4.1.2
AUXILIARY CRYOGENIC SYSTEMS
Only includes costing for minor connections to auxiliary systems such as VLPC dewar and nitrogen purge lines. Main costs for these systems carried elsewhere.
4.2.3
CONTROL DEWAR SYSTEM
Interfaces the transfer line to the service port: U Tubes, control valves, subcooler, instrumentation & reliefs.
4.1.3
SOLENOID COIL
Includes coil, chimney and service port. Tested in Japan. Also includes the cost of the Prototype magnet.
4.1.1
VACUUM SYSTEMS
Includes stationary turbo pumps for transfer line and coil cryostat as well as leak detection equipment for assembly.
4.2.4
Includes development and fabrication of a device to map the solenoid field.
4.1.7

	A	B	C	D
1	WBS NUMBER	WBS TITLE	QUANTITY	DESCRIPTION
2	4.1	Superconducting Solenoid		
3	4.1.1	Superconducting Coil	1	Superconducting solenoid coil (dimensions ~3.4m dia. x 8.5m len.).
4				Includes the costs of fabricating SC coil andthe cryostat costs for the vacuum vessel,
5				LIN shield, supports, chimney and service port. Fabricated and tested in Japan.
6				Interfaces with other parts of the detector with respect to mounting and assembly.
7	4.1.2	Power Supply System	1	Includes all elements required to power, protect and monitor the coil package
8				consisting of the power supply (2-5KA supplies), quench protection circuitry, dump
9				resistors (fast & slow) and instrumentation.
10				Interfaces with 480 VAC power panels in counting room.
11	4.1.3	Control Dewar System	1	Provides the connection point at the end of the transfer line system to the coil service port
12				and contains a subcooler and a variety of interconnect piping and valves.
13				Sits on top of the detector and interfaces with both the service port (SC Coil) and the
14				dewar for the VLPC system.
15	4.1.4	Controls & Instrumentation	1	Includes temperature, pressure and voltage sensors for the magnet package,
16				an uninteruptable power supply to allow for continuous control operation and
17				associated cabling. The cryogenic control system is part of the overall
18				refrigerator distributed digital control system and so this element only covers
19				the additional costs associated with magnet data channels.
20				Interfaces with the DDCS controls supplied by the refrigerator manufacturer.
21	4.1.5	Safety Report	1	A compilation of component lists, operating procedures, hazard and failure mode
22				and effects analysis, etc.
23				Interfaces with safety reports generated for the subsystems to form a
24				comprehensive analysis.
25	4.1.6	Assembly & Test	1	Includes the coil support system, used to mount to the detector, the necessary
26				specialty fixtures and equipment required for assembly and the test equipment.
27				Interfaces with the rest of the assembly of the detector.
28	4.1.7	Magnetic Field	1	Incorporates all elements of designing, fabrication, and testing a system
29		Mapping Equipment		to map the solenoids central field. Also includes the necessary field monitor equip.
30				Interfaces only in the final detector assembly steps.
31	4.1.8	Management & Integration	1	Includes all costs associated with managing the design, fabrication and testing of
32				the solenoid system. Travel to Japan is included since interfacing with the initial
33				construction and testing of the solenoid is essential.

	A	B	C	D
1	WBS NUMBER	WBS TITLE	QUANTITY	DESCRIPTION
2	4.2	Cryogenic Systems		
3	4.2.1	Refrigeration Systems		
4	4.2.1.1	Helium Refrigerator	1	Includes all costs associated with procuring a refrigeration system (~1.5KW) which is
5				installed and acceptance tested.
6				Interfaces with the surface facilities located in the utility building.
7	4.2.1.2	Liquid Nitrogen System	1	Includes the liquid nitrogen storage dewar (~20,000 gal.), transfer line and connections
8				to the refrigerator.
9				Interfaces to the refrigerator and surface facilities of the utility building.
10	4.2.1.3	Control System	1	The DDCS is part of element 4.2.1.1 and so only the costs associated with the LIN
11				system data channels appears here.
12				Interfaces with the main control system of the refrigerator and the experiment.
13	4.2.1.4	Assembly & Test	1	Includes costs associated with final assembly and testing of these elements into a
14				complete refrigerator system.
15				Interfaces with surface facilities in the utility building.
16	4.2.1.5	Safety Report	1	A compilation of component lists, operating procedures, hazard and failure mode and
17				effects analysis, etc.
18				Interfaces with safety reports generated for the subsystems to form a comprehensive analysis.
19	4.2.1.6	Management & Integration	1	Includes the necessary management and integration for the following: The status of the
20				procured subsystems and fabrication of the liquid nitrogen sybsystem.
21	4.2.2	Transfer Systems		
22	4.2.2.1	Cryogenic Transfer	1	Includes all elements associated with the transfer lines used to connect the refrigerator to the
23		Line System		solenoid. End cans, expansion boxes and straight sections fabricated then assembled @ SSCL.
24				Interfaces with the surface and hall facilities.
25	4.2.2.2	Gas Piping Systems	1	Piping systems for warm gas supplies and returns including the lead flows, nitrogen vents
26				and quench header. Connects from the top of the detector to the utility building.
27				Interfaces with the surface and hall layout.
28	4.2.2.3	Electrical Buss System	1	Insulated, water cooled copper pipe which connects the power supply system to the
29				control dewar. Includes all necessary piping supports.
30				Interfaces with the surface and hall layout.
31	4.2.2.4	Water Systems	1	Includes the necessary hook-ups to the ICW & LCW manifolds provided by Mechanical
32				Integration. Costs include piping, valves & instrumentation.
33				Interfaces with the utility building facilities.
34	4.2.2.5	Control System	1	The DDCS is part of element 4.2.1.1 and so only the costs associated with the Transfer
35				Systems data channels appears here.
36				Interfaces with the main control system of the refrigerator and the experiment.
37	4.2.2.6	Safety Report	1	A compilation of component lists, operating procedures, hazard and failure mode
38				and effects analysis, etc.
39				Interfaces with safety reports generated for the subsystems to form a comprehensive
40				analysis for the Transfer Systems.

	A	B	C	D
41	4.2.2.7	Management & Integration	1	Includes the necessary management of the separate transfer subsystems to assure a
42				comprehensive piping package connection from the surface to the hall.
43	**4.2.3**	**Aux. Cryo Support Systems**		
44	4.2.3.1	Cryo. Equipment for VLPC's	1	At this time, this element contains only the costs associated with providing additional
45				bayonet connections at the end can of the transfer line in the hall.
46				Costs associated with the VLPC cryogenic equipment, ie dewars, cryostats and connection
47				tubes are shown elsewhere.
48				Interfaces with the VLPC cryogenic system.
49	4.2.3.2	Equipment for Nitrogen Piping	1	At this time, this element contains only the costs associated with additional piping, valves
50				and instrumentation needed to supply nitrogen gas to a gas manifold which is costed
51				under Mechanical Integration.
52				Interfaces with "mechanical integration" manifold to supply gas to a variety of places in the detector.
53	**4.2.4**	**Vacuum Systems**		
54	4.2.4.1	Solenoid Vacuum System	1	Turbo pump system for evacuation of the cryostat vacuum insulation space.
55				Includes pump cost, piping and valves to assure reliable isolation.
56				Interface with detector and hall layout.
57	4.2.4.2	Transfer Line Vacuum System	1	Turbo pump system for evacuation of the transfer line vacuum insulation space. Includes
58				pump cart, piping and valves to assure reliable isolation.
59				Interfaces with detector and hall layout.
60	4.2.4.3	Auxilliary Vacuum System	1	Includes the additional turbo and rough pump, leak detectors, piping, valves and
61				instrumentation required for operation and maintenance of the cryogenic systems.
62				Interfaces with utility building facilities.
63	4.2.4.4	Vacuum Control System	1	The DDCS is part of element 4.2.1.1 and so only the costs associated with the Vacuum
64				Systems data channels appears here.
65				Interfaces with the main control system of the refrigerator and the experiment.
66	4.2.4.5	Safety Report	1	A compilation of component lists, operating procedures, hazard and failure mode analysis.
67				Interfaces with safety reports generated for the subsystems to form a comprehensive analysis for
68				the vacuum systems.
69	4.2.4.6	Management & Integration	1	Includes the necessary management of the vacuum subsystems to assure the coordination
70				of the separate specifications so as to end up with a consistent vacuum system.
71	**4.2.5**	**Safety Report**	1	Combines all the subsystem reports into a comprehensive safety report dealing with the
72				total cryogenic system. Adds the necessary sections due to subsystem interactions.
73	**4.2.6**	**Assembly & Test**	1	Includes all costs associated with combining all of the major subsystems into a cryogenic system
74				capable of operation from a central control point.
75	**4.2.7**	**Management & Integration**	1	Includes the necessary management of all subsystems into a cohesive refrigeration system
76				and the costs associated with quality control.

SUMMARY STATUS OF COST DATA

4.1.1 Superconducting Coil	Cost/Shedule estimate: -Supplied by Japan
4.1.2 Power Supply System	Cost estimate: -Vendor quote -Engineer estimate
4.1.3 Control Dewar System	Cost estimate: -Based on replacement cost of CDF control dewar.
4.1.4 Controls & Inst.	Cost estimate: -Engineer estimate based on communication with vendor.
4.1.5 Safety Report	Cost/Schedule estimate: -Based on FNAL experience
4.1.6 Assembly & Test	Cost/Schedule estimate: - Engineer estimate
4.1.7 Magnet Map Device	Cost/Schedule estimate: - Engineer estimate based on FNAL experience (Zip Track).
4.1.8 Mgm't & Integration	Cost estimate: - Engineer estimate based on CDF experience.

4.2.1 Refrigeration Systems	Cost/Schedule estimate: -Vendor quote -Engineer estimate
4.2.2 Transfer Systems	Cost/Schedule estimate: -Detailed engineer estimate
4.2.3 Aux. Cryo Systems	Cost/Schedule estimate: -Engineer estimate
4.2.4 Vacuum Systems	Cost estimate: -Vendor quote
4.2.5 Safety Report	Cost/Schedule estimate: -Based on FNAL experience
4.2.6 Assembly & Test	Cost/Schedule estimate: - Engineer estimate
4.2.7 Mgm't & Integration	Cost estimate: - Engineer estimate based on CDF experience.

SDC SOLENOID/CRYOGENIC SYSTEM
COST/SCHEDULE DRIVERS

	DURATION	MILESTONE
PROTOTYPE MAGNET	2.25 YEARS	FEB 94 TEST/ AN
SOLENOID COIL	4.25 YEARS	FEB 97 TEST APAN
HELIUM SYSTEM	4.75 YEARS	JUL 97 TES SCL
INSTALLATION & TEST "IN HALL"	0.75 YEARS	JUN 98 MAP MAG

	MAT'L & LAB	EDIA	% EDIA	SUB TOT	CONT	% CONT	TOT
4.0 SC MAGNET	29.2	3.1	10%	32.3	10.1	31%	42.4
4.1 SC SOLENOID	23.8	1.8	7%	25.6	8.3	33%	33.9
4.2 CRYOGENIC SYSTEM	5.4	1.3	19%	6.7	1.8	27%	8.5

Superconducting Coil as a % of Total 4.1 costs = 75.8%

Helium Refrigeration System as a % of Total 4.2 costs = 55.5%

COST NUMBERS SUPPLIED BY TAKA KONDO:

		WBS #	Cont.	Base $
PROTOTYPE SOLENOID	$5.4 M	4.1.1.8	68%	3.27M
Design, management	$.36 M			
Superconductor	$1.1 M			
Coil Winding	$1.2 M			
Cryostat & Cryogenics	$1.0 M			
Power Supply for Test	$.86 M			
Monitors	$.14 M			
Assembly & Inspection	$.29 M			
Excitation Test	$.36 M			
SDC SOLENOID	$26.8 M	4.1.1		
Less Installation Costs = $1.1 M.....	$25.7 M			
Design, Management	$1.4 M	4.1.1.7	38%	1.02M
Supercondutor	$5.7 M	4.1.1.1	24%	4.60M
Coil Winding	$5.6 M	4.1.1.2	28%	4.38M
Cryostat	$5.4 M	4.1.1.3	24%	4.36M
Monitor System	$1.2 M	4.1.1.4	24%	.968M
Assembly & Inspection	$3.6 M	4.1.1.5	32%	2.73M
Excitation Test	$2.1 M	4.1.1.5	32%	1.59M
Transportation	$.71 M	4.1.1.6	16%	.612M
Installation & Test	$1.1 M			

140 yen = $1

SDC Superconducting Solenoid Cost Summary

WBS		Mat'ls. ($k)	Mfg Labor ($k)	EDIA ($k)	Base ($k)	Cont. ($k)	Cont. %	Total w/ Cont. ($k)
11	Superconducting Coil	21,923	0	0	21,923	7,188	32.8	29,111
12	Power Supply System	366	303	594	1,263	296	23.4	1,560
13	Control Dewar System	262	20	173	455	127	27.9	582
14	Controls & Instrument.	110	140	138	388	124	32.0	512
15	Safety Report	30	0	120	150	39	26.0	189
16	Assembly & Test	100	69	189	358	158	44.1	516
17	Field Mapping Eqpt.	250	184	173	607	243	40.0	850
18	Mgmt. & Integ.	40	0	384	424	161	38.0	585
1	Total S.C. Solenoid	23,081	716	1,771	25,568	8,337	32.6	33,906

WBS	Description	Materials (K $)	Manuf. Labor (K $)	Materials + Manuf. Labor (K $)	EDIA (K $)	EDIA (%)	Subtotal (K $)	Contingency (K $)	Contingency (%)	Total (K $)
4.1	Superconducting Solenoid	23,081	716	23,797	1,771	6.9	25,569	8,337	32.6	33,906
4.1.1	Superconducting Coil	21,923	0	21,923	0	.0	21,923	7,188	32.7	29,111
4.1.1.1	Superconducting Wire	4,597	0	4,597	0	.0	4,597	1,103	24.0	5,700
4.1.1.2	Coil Winding Equipment	4,375	0	4,375	0	.0	4,375	1,225	28.0	5,600
4.1.1.3	Cryostat System	4,355	0	4,355	0	.0	4,355	1,045	24.0	5,400
4.1.1.4	Instrumentation System	968	0	968	0	.0	968	232	24.0	1,200
4.1.1.5	Assembly & Test	2,727	0	2,727	0	.0	2,727	873	32.0	3,600
4.1.1.6	Transportation to SSCL	612	0	612	0	.0	612	98	16.0	710
4.1.1.7	Management & Integration	1,015	0	1,015	0	.0	1,015	386	38.0	1,401
4.1.1.8	Prototype Magnet	3,274	0	3,274	0	.0	3,274	2,226	68.0	5,500
4.1.2	Power Supply System	366	303	669	594	46.9	1,264	296	23.4	1,560
4.1.2.1	Prime Mover	122	5	127	38	23.0	165	26	16.0	191
4.1.2.2	Switches & SCRs	31	32	63	61	49.1	124	20	16.0	144
4.1.2.3	Dump Resistors	61	12	73	38	33.9	112	18	16.0	130
4.1.2.4	Quench Protection System	40	28	68	138	66.9	206	66	32.0	272
4.1.2.5	Current Transducers & Instr.	40	15	55	72	56.6	127	41	32.0	168
4.1.2.6	AC Cabling & Breakers	60	55	115	75	39.4	190	30	16.0	220
4.1.2.7	Assembly & Test	12	156	168	172	50.5	340	95	28.0	435
4.1.3	Control Dewar System	262	20	282	173	38.0	455	127	28.0	582
4.1.4	Controls & Instrumentation	110	140	250	138	35.5	388	124	32.0	512
4.1.5	Safety Report	30	0	30	120	80.0	150	39	26.0	189
4.1.6	Assembly & Test	100	69	169	189	52.7	358	158	44.0	516
4.1.7	Magnetic Field Mapping Eqpt.	250	184	434	173	28.5	607	243	40.0	850
4.1.8	Management & Integration	40	0	40	384	90.5	424	161	38.0	585

SDC Cryogenics System Cost Summary

WBS #		Mat'ls. ($k)	Mfg Labor ($k)	EDIA ($k)	Base ($k)	Cont. ($k)	Cont. %	Total w/ Cont. ($k)
4.2.1	Refrigeration Systems	3,913	28	453	4,394	1,252	28.5	5,646
4.2.2	Transfer Systems	668	424	418	1,511	332	22.0	1,843
4.2.3	Auxilliary Cryogenic Sppt.	20	4	43	68	22	32.4	90
4.2.4	Vacuum Systems	189	42	133	365	92	25.2	457
4.2.5	Safety Report	2	0	104	106	23	21.7	129
4.2.6	Assembly & Test	10	82	23	115	41	35.7	156
4.2.7	Mgmt. & Integration	5	0	126	131	29	22.1	160
	Total Cryogenics Sys.	4,807	580	1,300	6,690	1,792	26.8	8,482

SDC DETECTOR U.S. COST ESTIMATE SUMMARY

WBS	Description	Materials (K $)	Manuf. Labor (K $)	Materials + Manuf. Labor (K $)	EDIA (K $)	EDIA (%)	Subtotal (K $)	Contingency (K $)	Contingency (%)	Total (K $)
4.2	Cryogenic Systems	4,807	580	5,387	1,300	19.4	6,690	1,792	26.7	8,482
4.2.1	Refrigeration Systems	3,913	28	3,941	453	10.3	4,394	1,252	28.4	5,646
4.2.1.1	Helium Refrigerator	3,467	0	3,467	155	4.2	3,622	1,087	30.0	4,709
4.2.1.2	Liquid Nitrogen System	425	0	425	183	30.1	608	128	21.0	736
4.2.1.3	Control System	10	1	11	14	56.0	25	6	24.0	31
4.2.1.4	Assembly & Test	5	27	32	29	47.5	61	17	28.0	78
4.2.1.5	Safety Report	1	0	1	26	96.3	27	5	18.0	32
4.2.1.6	Management & Integration	5	0	5	46	90.2	51	9	18.0	60
4.2.2	Transfer Systems	668	424	1,092	418	27.6	1,511	332	21.9	1,843
4.2.2.1	Cryogenic Transfer Line	279	244	523	208	28.4	731	150	20.5	881
4.2.2.2	Gas Piping System	270	139	409	83	16.8	492	118	24.0	610
4.2.2.3	Electrical Buss System	90	20	110	27	19.7	137	33	24.0	170
4.2.2.4	Water Systems	6	20	26	19	42.2	45	11	24.0	56
4.2.2.5	Control System	20	1	21	12	35.2	34	8	24.0	42
4.2.2.6	Safety Report	1	0	1	23	95.8	24	4	16.0	28
4.2.2.7	Management & Integration	2	0	2	46	95.8	48	8	16.0	56
4.2.3	Auxilliary Cryogenic Support	20	4	24	43	63.2	68	22	32.0	90
4.2.3.1	Cryogenic Equipment for VLPCs	10	2	12	29	70.7	41	13	32.0	54
4.2.3.2	Equipment for Nitrogen Purging	10	2	12	14	51.8	27	9	32.0	36
4.2.4	Vacuum Systems	189	42	231	133	36.4	365	92	25.3	457
4.2.4.1	Solenoid Vacuum System	32	11	43	35	44.8	78	22	28.0	100
4.2.4.2	Transfer Line Vacuum System	30	10	40	19	32.2	59	17	28.0	76
4.2.4.3	Auxilliary Vacuum System	90	16	106	33	23.5	140	34	24.0	174
4.2.4.4	Vacuum Control System	30	5	35	11	23.9	46	13	28.0	59
4.2.4.5	Safety Report	2	0	2	23	92.0	25	5	18.0	30
4.2.4.6	Management & Integration	5	0	5	12	70.5	17	3	18.0	20
4.2.5	Safety Report	2	0	2	104	98.1	106	23	22.0	129
4.2.6	Assembly & Test	10	82	92	23	20.0	115	41	36.0	156
4.2.7	Management & Integration	5	0	5	126	96.1	131	29	22.0	160

4.1 Solenoid Subsystem Milestones

4.1.1 Superconducting Coil

DATE	MILESTONE DESCRIPTION
May-94	Complete Fixed Design Report/Start Fabrication
Mar-95	Superconductor fabricated
Feb-96	Complete winding of SC Coil
Oct-96	Complete magnet assembly in cryostat
Feb-97	Magnet tested (in air)
Mar-97	Arrives at SSCL
Apr-97	Available TOH

4.1.1.8 Prototype Coil

DATE	MILESTONE DESCRIPTION
Feb-93	Complete winding of SC Coil
Feb-93	Vacuum vessel delivered to Japan
Oct-93	Complete magnet assembly in cryostat
Feb-94	Magnet tested (in air)

4.1.2 Power Supply System

DATE	MILESTONE DESCRIPTION
Nov-95	Complete design of power supply & QPM
May-96	Fabricate power supply/QPM system
Nov-96	Test system
Dec-96	Power supply system delivered to Japan

4.1.3 Control Dewar System

DATE	MILESTONE DESCRIPTION
Mar-96	Complete design of Control Dewar
Feb-97	Complete fabrication of Control Dewar
Mar-97	Test Control Dewar
May-97	Control Dewar arrives at SSCL

4.1.4 Controls and Instrumentation

DATE	MILESTONE DESCRIPTION
Mar-95	Complete design of integrated controls system
Mar-96	Complete fabrication of integrated controls system
May-97	Controls system available at SSCL

4.1.7 Magnetic Field Mapping Equipment

DATE	MILESTONE DESCRIPTION
Mar-96	Complete design of equipment
May-97	Complete fabrication of equipment
Aug-97	Equipment delivered to SSCL
Oct-97	Available TOH

4.2 Cryogenic Systems

4.2.1 Refrigeration Systems

DATE	MILESTONE DESCRIPTION
Feb-94	Issue contract for helium refrigerator
Mar-94	Complete design of integrated cryogenic system
Mar-95	Issue contract for LN_2 dewar
Mar-96	Assembly start at SSCL
Jun-97	Assembly complete at SSCL
Jul-97	Available TOH

4.2.2 Transfer Systems

DATE	MILESTONE DESCRIPTION
May-96	Complete design of integrated transfer systems
Feb-96	Assembly start at SSCL
May-97	Assembly complete at SSCL
Jul-97	Testing complete

4.2.3 Auxiliary Cryogenic Support Systems

DATE	MILESTONE DESCRIPTION
Apr-96	Complete design of cryogenic equipment for VLIC's, nitrogen purge systems
Jun-97	Complete fabrication of systems
Jul-97	Assembly complete at SSCL

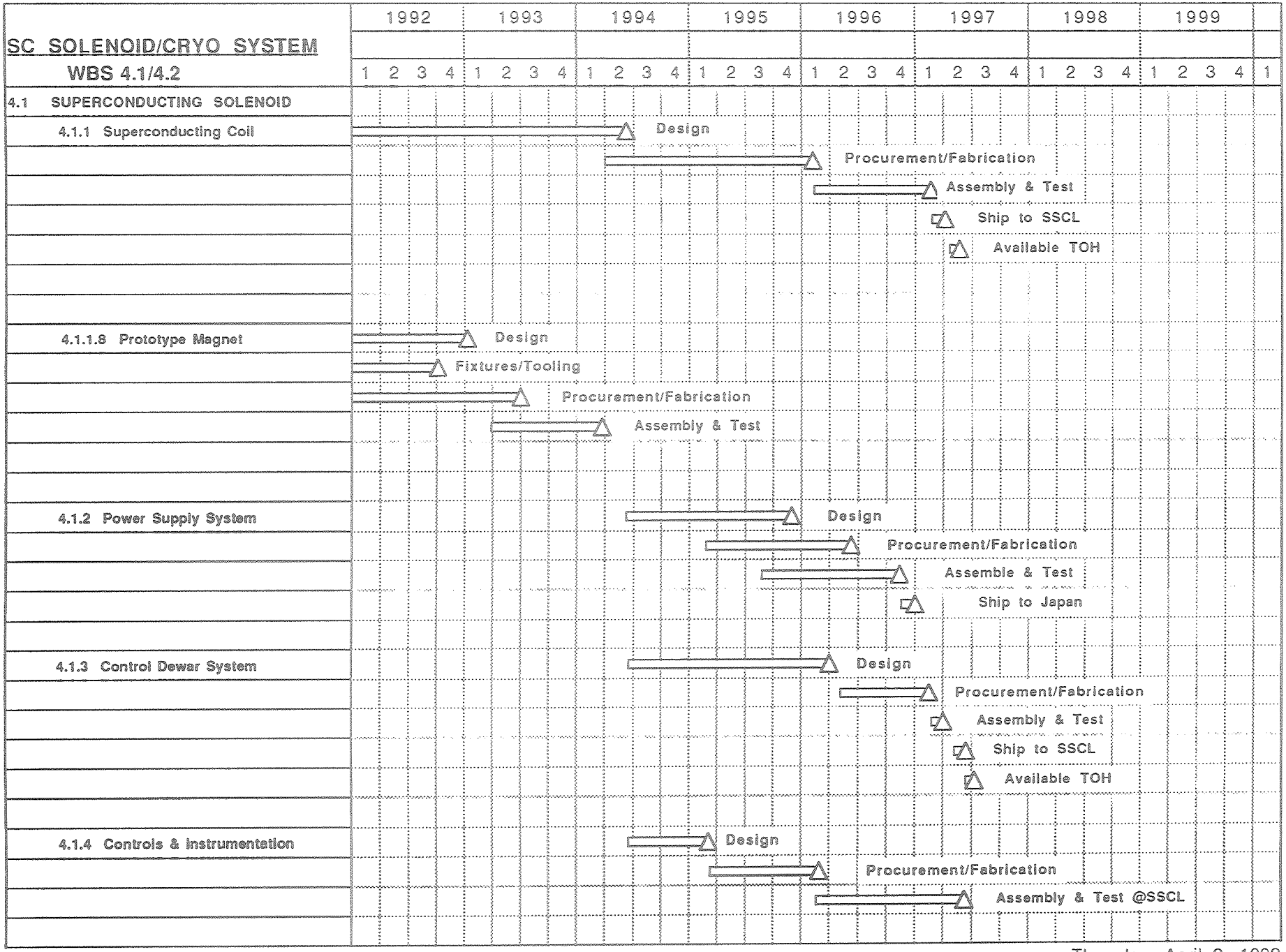
4.2.4 Vacuum Systems

DATE	MILESTONE DESCRIPTION
Jan-96	Complete design of vacuum systems
Mar-97	Complete fabrication of vacuum systems
Apr-97	Assembly complete at SSCL

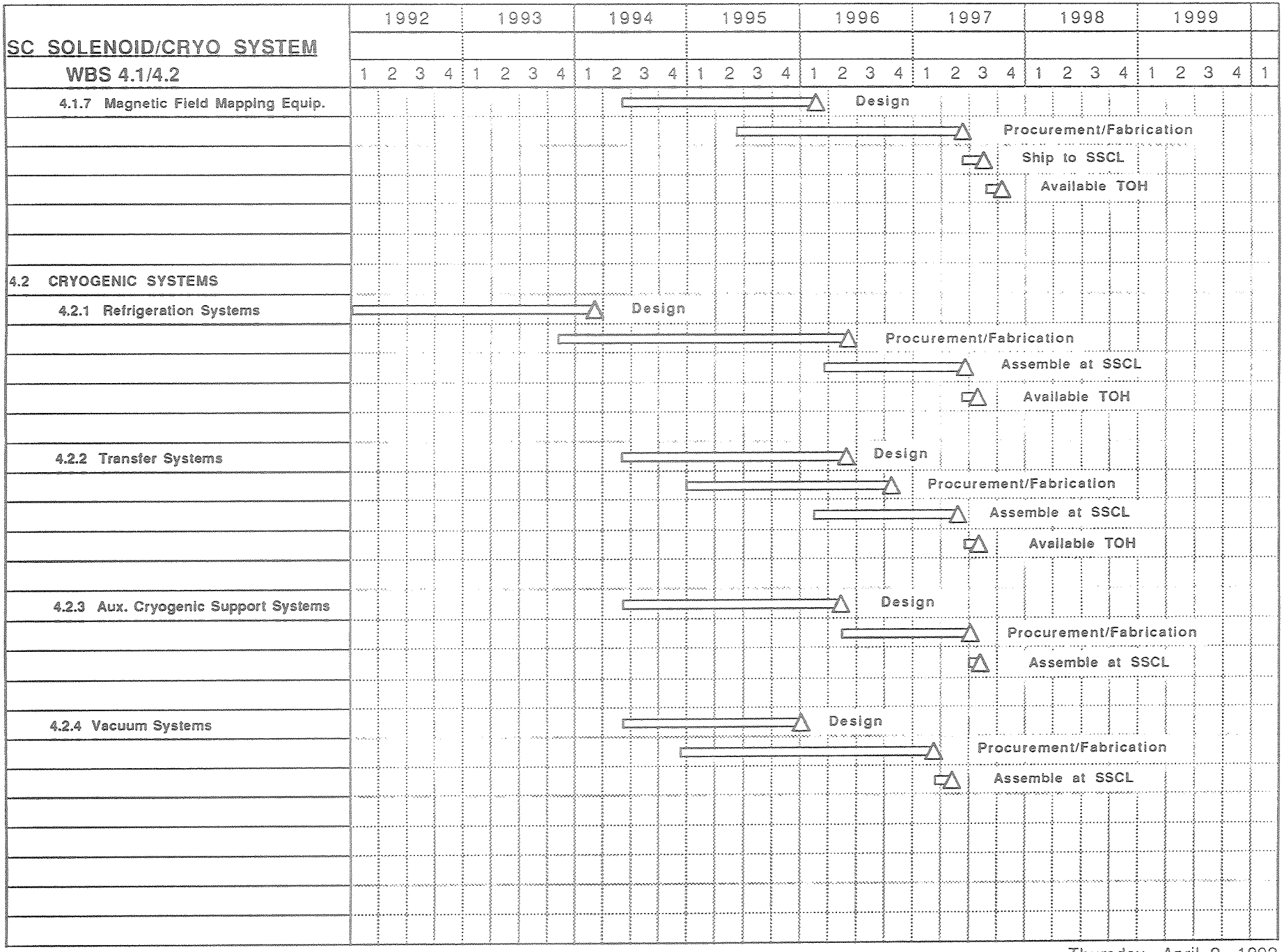
Table 5-17

Overall schedule for the prototype solenoid and the production solenoid. The Japanese fiscal year begins April 1 of the year indicated.

JFY1991	Prototype Magnet Development
	—Superconductor fabrication
	—Winding machine development
	—Outer support cylinder fabrication
	—Isogrid vacuum wall development
JFY1992	—Coil winding
	—Cryostat element fabrication
JFY1993	—Assembly of the magnet
	—Cool-down and excitation in air
JFY1994	Production Magnet Fabrication
	—Superconductor fabrication
	—Cryostat element fabrication
JFY1995	—Coil winding
	—Magnet assembly
JFY1996	—Magnet assembly continued
	—Cool-down and excitation test in air
	—Transportation to SSCL
JFY1997	—Cool-down and excitation in iron
	—Field mapping



Thursday, April 2, 1992



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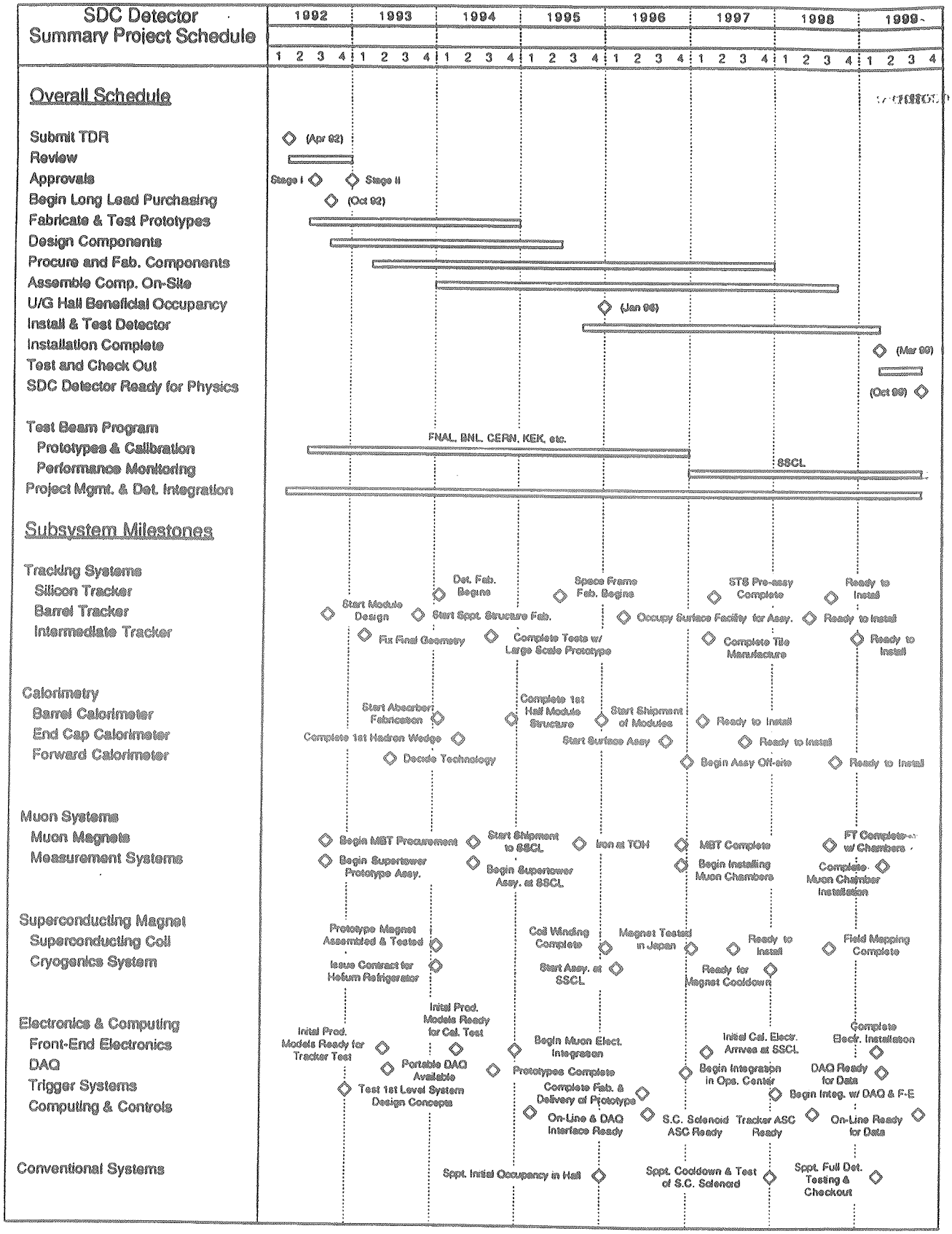


FIG. 15-1. A summary of the schedule for the design, construction and installation of the SDC detector.

REALITY CHECK:

* Compare Manpower Estimate of SDC with CDF Experience

Magnet Support

Classification:	CDF Experience	SDC Estimate
Engineer	7.5 manyears	7.5 manyears
Engineer Assoc.	1.5 manyears	1.5 manyears
Drafting	2.0 manyears	3.0 manyears
Technicians	2.0 manyears	4.1 manyears

Electrical Support

Classification:	CDF Experience	SDC Estimate
Engineer	2.5 manyears	5.0 manyears
Engineer Assoc.	2.5 manyears	1.0 manyears
Drafting	2.5 manyears	2.3 manyears
Technicians	5.0 manyears	7.5 manyears

Refrigerator Support

Classification:	CDF Experience	SDC Estimate
Engineer	6.0 manyears	10.7 manyears
Engineer Assoc.	1.5 manyears	1.5 manyears
Drafting	2.0 manyears	3.7 manyears
Technicians	5.0 manyears	6.8 manyears

TOTAL SUPPORT:

Classification:	CDF Experience	SDC Estimate
Engineer	16.0 manyears } 21.5	23.2 manyears } 27.2
Engineer Assoc.	5.50 manyears	4.00 manyears
Drafting	6.50 manyears	9.00 manyears
Technicians	12.0 manyears	18.4 manyears
	40	54.6 my

It appears that the level of manpower estimated for SDC is comparable with that used for CDF in some areas. As expected, the level of manpower is higher in total.

REALITY CHECK II

* Compare Cost Estimate of SDC with LBL paper by R. Byrns
  "Estimating the Cost of Superconducting Magnets and the Refrigerators to Keep Them Cold"

Cost Equations for Solenoid Magnets:

$C(M\$) = 0.523\,[E(MJ)]^{.662} = 0.523\,[146]^{.662} = 14.2\ M\$$

$C(M\$) = 0.868\,[V(Tm^{3})]^{.577} = 0.868\,[145]^{.577} = 15.4\ M\$$

SDC Estimates = 20.2 M$ Base
5.5 M$ Cont

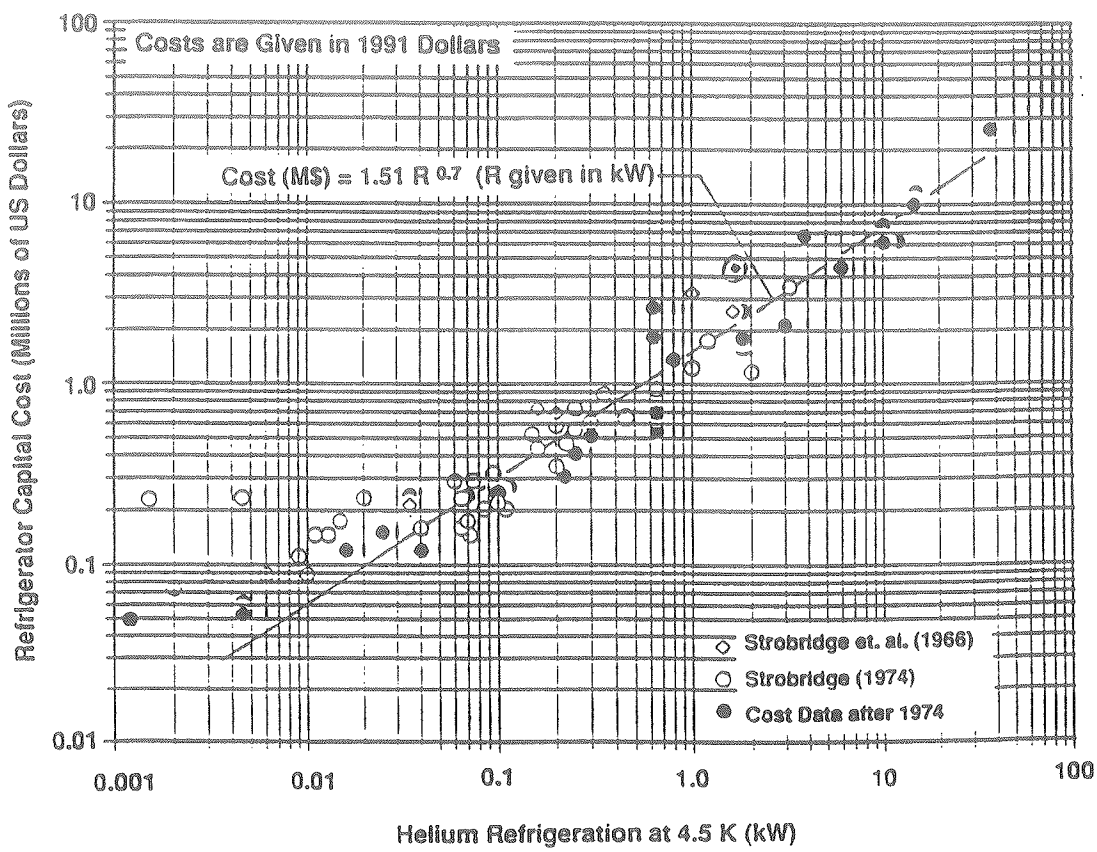
25.7 M$ Total

Cost Equations for Helium Refrigeration:

$C(M\$) = 1.51\,[R(kW)]^{.7} = 1.51\,[1.5]^{.7} = 2.0\ M\$$

SDC Estimates = 3.6 M$ Base
1.1 M$ Cont

4.7 M$ Total



SDC REALITY CHECK III

COMPARE THE SCALED UP HISTORICAL COSTS OF CDF TO SDC ESTIMATES:

CDF magnet in 1983-84 dollars cost $4M (600M yen) [Parameters=30MJ and 1.5T]

Scaled for inflation = $5.3M (4%, 7 years)

Scaled for stored energy = $15.1M (using formula; $[146/30]^{.662}$)

* This compares favorably with the costs generated by LBL cost equations.

CDF refrigerator in 1983-84 dollars cost $1M [Parameters=.6KW, FNAL labor]

Scaled for inflation = $1.5M (6%, 7 years)

Scaled for refrigeration = $2.9M (using formula; $[1.5/.6]^{.7}$)

* This is more than the costs generated by the LBL cost equation but less than the quote from the vendor (which is expected).