# Cryogenic Cooling System for the E951 Pulsed Solenoid Magnet

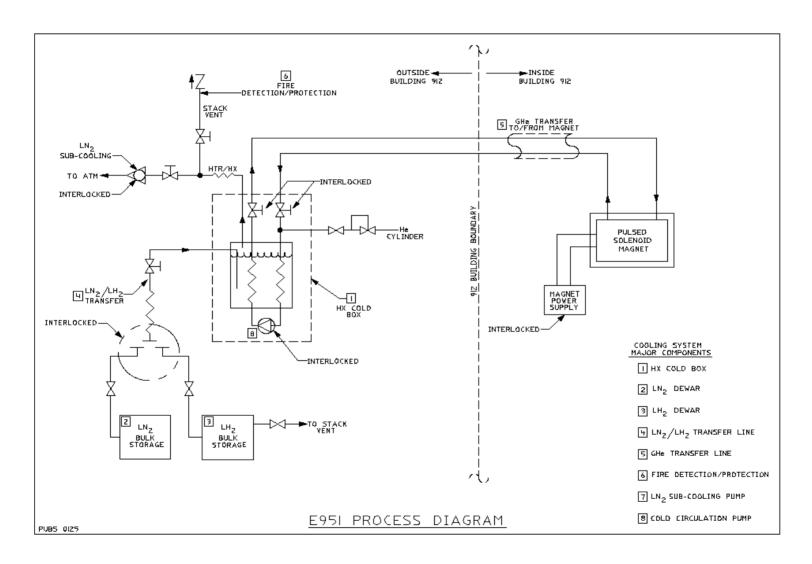
- Basic System Description/Cooling Scheme
- Cooling Scheme Conceptual P&ID
  - Plan Arrangement, Heat Exchanger Detail & Picture
- System Parameters
  - Circulation Pump Specifications
- Summary of Predicted Heat Exchanger Performances
- Experimental Safety Considerations and Plan
- Cryogen Usage and Case Dependant Operational Costs
- Phased Construction and Installation Costs

Michael Iarocci Brookhaven National Laboratory

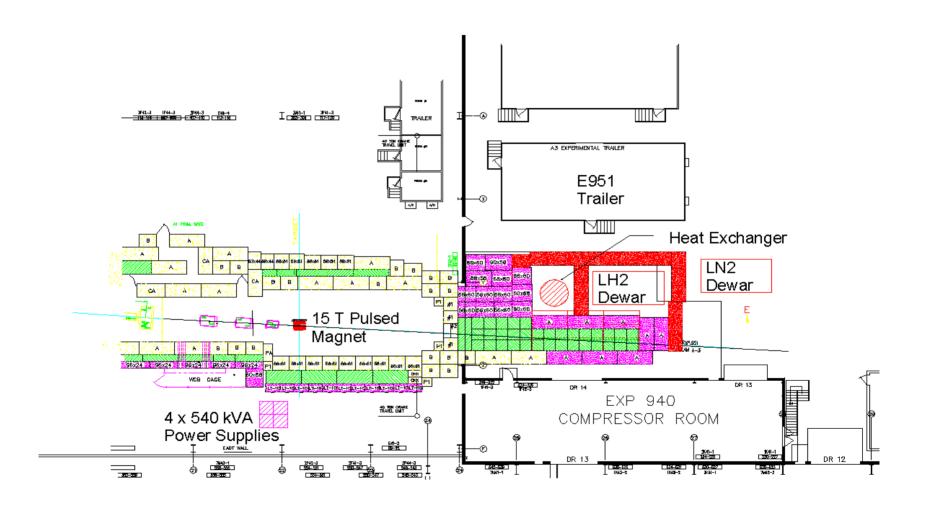
#### System Description

- Magnet energy removal via circulation of gaseous helium at 66 K or 22 K in a closed loop configuration. Phased Temperature Approach.
- Refrigeration via bulk LN2 (sub-cooled to 65K) or bulk LH2 @ ~22 K.
- Existing tube-in-shell heat exchanger and cold box from the SSC Westinghouse Facility in Hammond.
- LN2 and LH2 including the Heat Exchanger located outdoors to mitigate the safety issues associated with the use of LH2.

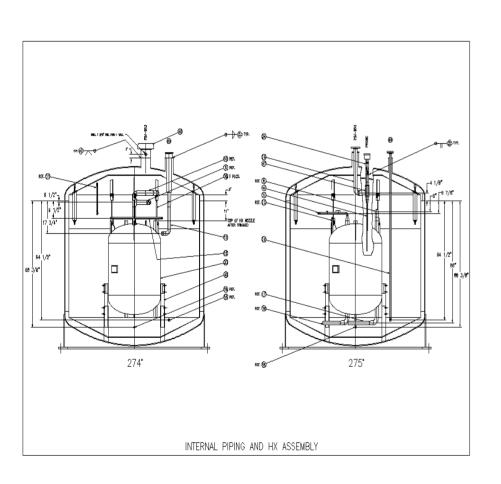
### Cooling System P&ID

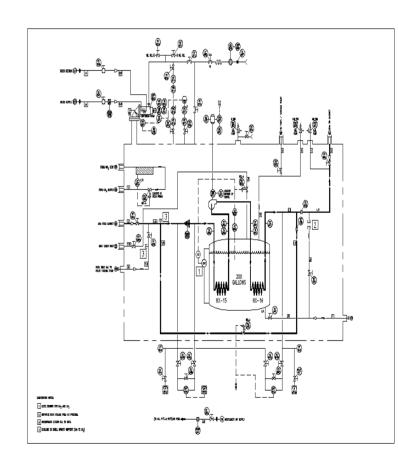


## Experimental Plan Layout



## Heat Exchanger Detail





## Heat Exchanger Cold Box



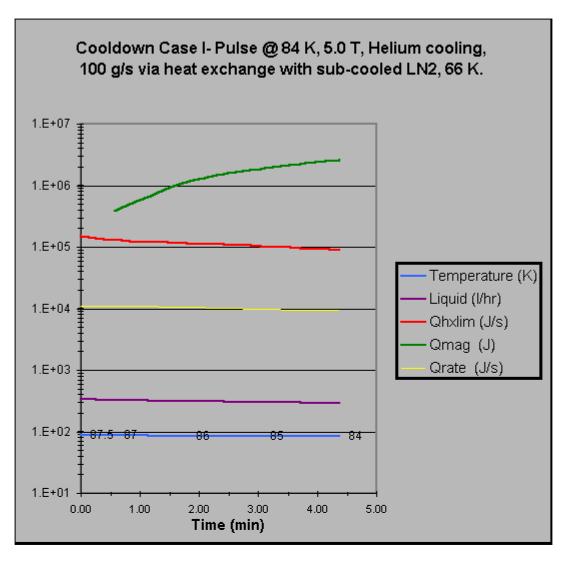
#### Cryogenic System Parameters

- Magnet Cold Mass- 3,600 kg
- Helium Loop Mass Flow- 100 g/s
- Magnet Energy Removed/Pulse- ~3-15 MJ
- Possible Rep Rate High Temp- >10/hr
- High Temperature Helium Delivery- ~66 K
- · Low Temperature Helium Delivery- ~22 K
- Energy Removal Rate (Low Temp) ~25 kJ/s
- Energy Removal Rate (High Temp) ~10 kJ/s
- Bulk LH2 Storage Capacity-5000 gallons ~19,000 L
- Simple Controls- cover all alarm, interlock, and system status with 10 analog and 10 digital signals

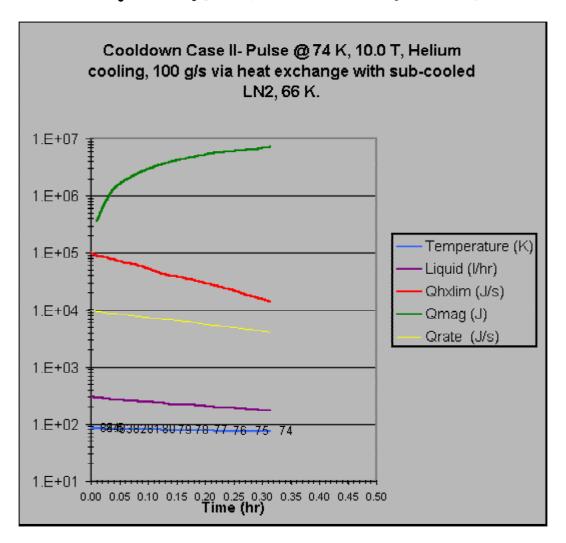
#### Circulation Pump Specifications

- · Semi-hermetic Centrifugal Configuration
- Working Pressure- 15 ATM
- Head Pressure 1.5 ATM
- Mass Flow Rate- 100 g/s
- Efficiency- ~ 45%
- Pump Work (66 K Mode)- 3.2 kW (~ 25%)
- Pump Work (22 K Mode)- 1.1 kW (~ 5%)
- Turn-down Ratio- ~ 4 (Standby operation)

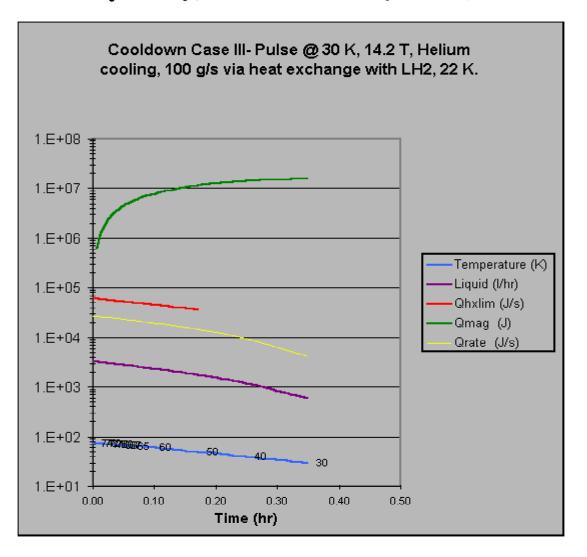
### Expected Heat Exchanger Performance 84 K Pulse



# Expected Heat Exchanger Performance 74 K Pulse



### Expected Heat Exchanger Performance 30 K Pulse



# Experimental Safety Considerations and Plan

- A sub-group of the Experimental Safety Review Committee (ESRC) of the Collider-Accelerator Department was tasked with the Preliminary safety Assessment of E951
- LH2 Storage Installation 5000 gallons
  - Fire Detection and Protection (N2 Stack Purge)
  - Blast Protection for Personnel and Structures- 400'
- Cold Box Volume is 200 gallons so it may be closer to the building, thus reducing transfer line cost
- When the Experimental Arrangement is Settled the ESRC and Cryogenic Safety Committee will need formal presentations of quantified hazards

#### Cryogen Usage and Operational Costs

- High Temperature Operation with LN2 Case I
  - Cooling 87.5 to 84 K (5 min) ~ 365 L/hr ~ \$1.60/ pulse
  - Cooling 87.5 to 84 K (Continuous) ~ \$19/hr
  - Standby Operation ~ 70 L/hr ~ \$3.60/hr
- High Temperature Operation with LN2 Case II
  - Cooling 84.5 to 74 K (20 min) ~ 325 L/hr ~ \$5.60/pulse
  - Cooling 84.5 to 74 K (Continuous) ~ \$17/hr
  - Standby Operation ~ 70 L/hr ~ \$3.60/hr
- Low Temperature Operation with LH2 Case III
  - Cooling 74 to 30 K (25 min) ~ 2700 L/hr ~ \$290/pulse
  - Cooling 74 to 30 K (Continuous) ~ \$700/hr
  - Standby Operation ~ 220 L/hr ~ \$60/hr

#### Installation Cost Estimate Case 1 & 2

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Phase   Livis Only						<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>				\$K/ hr.	
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II-C   Installation   \$0.00															
II-D   Installation															
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III-A   Install Vac   \$0.00			LH2/ LN2/	\$0.00	\$0.00	\$0.00	\$0.00	\$15.00	\$3.00	\$22.05	\$5.61	\$0.00	\$0.00	\$0.00	\$0.00
III-A   Install Vac   \$0.00															
III-B															
III-C   Welding-   \$0.00   \$	111-	I-A													
III-D   AC Power; \$0.00   \$0.00   \$0.00   \$0.00   \$0.00   \$3.00   \$0															
III-E   Instrument   \$0.00   \$0.00   \$0.00   \$0.00   \$0.00   \$3.00   \$0.00   \$4.41   \$0.00															
III-F   Relief Valw   \$0.00	111	I-D	AC Power;	\$0.00	\$0.00	\$0.00	\$0.00	\$8.00	\$0.00	\$11.76	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Warm Pip  \$0.00	111-	I-E	Instrument	\$0.00	\$0.00	\$0.00	\$0.00	\$3.00	\$0.00	\$4.41	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
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IV-C															
Misc. Con  \$0.00															
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V-B															<del> </del>
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VI-A   Materials   \$0.00   \$															
VI-B   Install Lew   \$0.00   \$0.00   \$0.00   \$0.00   \$4.00   \$3.00   \$5.88   \$5.61   \$0.00															
VI-C   Modify Pip   \$0.00   \$0.00   \$0.00   \$0.00   \$4.00   \$4.00   \$5.88   \$7.48   \$0.00															
VI-D   Provide Fil   \$0.00   \$0.00   \$0.00   \$0.00   \$2.00   \$3.00   \$2.94   \$5.61   \$0.00	V	I-B	Install Leve	\$0.00	\$0.00	\$0.00	\$0.00	\$4.00	\$3.00	\$5.88	\$5.61	\$0.00	\$0.00	\$0.00	\$0.00
VI-D   Prowde Fil   \$0.00   \$0.00   \$0.00   \$0.00   \$2.00   \$3.00   \$2.94   \$5.61   \$0.00	V	'I-C	Modify Pip	\$0.00	\$0.00	\$0.00	\$0.00	\$4.00	\$4.00	\$5.88	\$7.48	\$0.00	\$0.00	\$0.00	\$0.00
VI-E   Procure Ne   \$40.00   \$0.00   \$47.00   \$0.00	V				\$0.00	\$0.00	\$0.00	\$2.00		\$2.94	\$5.61	\$0.00	\$0.00	\$0.00	\$0.00
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#### Installation Cost Estimate Case 3

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	Item #	Task Desc	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s
	I	Engineerin	g & Design											
	I-A	Develop Co	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$10.00	\$0.00	\$18.70	\$0.00	\$0.00	\$0.00	\$0.00
	I-B	Detail P&I	\$0.00	\$3.00	\$0.00	\$5.61	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	I-C	Verify Hx 9	\$0.00	\$3.50	\$0.00	\$6.55	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	I-D	Establish a	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$7.00	\$0.00	\$13.09	\$0.00	\$0.00	\$0.00	\$0.00
	I-E	Detail Cold		\$0.00	\$0.00	\$0.00	\$0.00	\$5.00	\$0.00	\$9.35	\$0.00	\$0.00	\$0.00	\$0.00
	I-F	Develop E		\$15.00	\$0.00	\$28.05	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	I-G	Detailed P		\$0.00	\$0.00	\$0.00	\$0.00	\$4.00	\$0.00	\$7.48	\$0.00	\$0.00	\$0.00	\$0.00
	I-H	Specificati		\$0.00	\$0.00	\$0.00	\$0.00	\$6.00	\$0.00	\$11.22	\$0.00	\$0.00	\$0.00	\$0.00
	1-1-1	Engineerin		\$21.50	\$0.00	\$40.21	\$0.00	\$32.00	\$0.00	\$59.84	\$0.00	\$0.00	\$0.00	\$0.00
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	II-A	Procure G		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$70.00	\$0.00	\$102.90	\$0.00
	II-B	Procure LI		\$0.00	\$0.00	\$0.00	\$3.00	\$0.00	\$4.41	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	II-C	Installation		\$0.00	\$0.00	\$0.00	\$10.00	\$0.00	\$14.70	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	II-D	Installation		\$0.00	\$0.00	\$0.00	\$0.00	\$9.50	\$0.00	\$17.77	\$0.00	\$0.00	\$0.00	\$0.00
		LH2/ LN2/	\$0.00	\$0.00	\$0.00	\$0.00	\$13.00	\$9.50	\$19.11	\$17.77	\$70.00	\$0.00	\$102.90	\$0.00
	111	Warm Pipi	ing & Sub-c	cooling Pum			I							
	III-A	Install Vac	\$0.00	\$0.00	\$0.00	\$0.00	\$5.00	\$0.00	\$7.35	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	III-B	Piping & F	\$0.00	\$0.00	\$0.00	\$0.00	\$3.00	\$0.00	\$4.41	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	III-C	Welding- v	\$0.00	\$0.00	\$0.00	\$0.00	\$8.00	\$6.00	\$11.76	\$11.22	\$0.00	\$0.00	\$0.00	\$0.00
	III-D	AC Power		\$0.00	\$0.00	\$0.00	\$8.00	\$0.00	\$11.76	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	III-E	Instrument		\$0.00	\$0.00	\$0.00	\$3.00	\$0.00	\$4.41	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	III-E	Relief Valv		\$0.00	\$0.00	\$0.00	\$3.00	\$0.00	\$4.41	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
	111-1-	Warm Pipi		\$0.00	\$0.00	\$0.00	\$30.00	\$6.00	\$44.10	\$11.22	\$0.00	\$0.00	\$0.00	\$0.00
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	IV-A	Misc. Con Level & Pr PLC & I/O Equipment	Materials Cost K\$'s trols & Instr \$0.00 \$0.00	Labor Cost K\$'s rumentation \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$0.00 \$2.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76	\$1.87 \$0.00 \$13.09
	IV IV-A IV-B	Misc. Con Level & Pr PLC & I/O	Materials Cost K\$'s trols & Instr \$0.00 \$0.00	Labor Cost K\$'s rumentation \$0.00	Burdened Materials Cost K\$'s	Labor Cost K\$'s \$0.00 \$0.00	Materials Cost K\$'s \$0.00	Labor Cost K\$'s \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$0.00	Labor Cost K\$'s \$1.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00	\$1.87 \$0.00 \$13.09
	IV IV-A IV-B	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s rumentation \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$0.00 \$2.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76	\$1.87 \$0.00 \$13.09
	IV IV-A IV-B IV-C	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00	Labor Cost K\$'s rumentatior \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$22.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85	\$1.87 \$0.00 \$13.09 \$14.96
	IV IV-A IV-B IV-C	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s rumentatior \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$22.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85	\$1.87 \$0.00 \$13.09 \$14.96
	IV IV-A IV-B IV-C V V-A V-B	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$stem \$0.00	Labor Cost K\$'s rumentation \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$22.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85	\$1.87 \$0.00 \$13.09 \$14.96
	IV IV-A IV-B IV-C V V-A V-B V-C	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys	Materials Cost K\$'s trols & Inst \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s umentatior \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$22.00 \$3.00 \$3.00 \$3.00 \$3.00 \$3.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85  \$0.00 \$0.00 \$2.55	\$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.00
	IV IV-A IV-B IV-C V V-A V-B	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s rumentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$2.00 \$2.00 \$2.00 \$2.00 \$10.00 \$10.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$51.09 \$2.76 \$53.85  \$0.00 \$0.00 \$2.85.385	\$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.00 \$0.00
	IV IV-A IV-B IV-C V V-A V-B V-C	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s umentatior \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$22.00 \$3.00 \$3.00 \$3.00 \$3.00 \$3.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85  \$0.00 \$0.00 \$2.55	\$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00
	IV IV-A IV-B IV-C V-A V-B V-C V-D	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Safety Sys	Materials Cost K\$'s trols & Instr \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s rumentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$20.00 \$2.00 \$2.00 \$2.00 \$2.00 \$10.00 \$10.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$51.09 \$2.76 \$53.85  \$0.00 \$0.00 \$2.85.385	\$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.00 \$0.00
	IV IV-A IV-B IV-C V-A V-A V-C V-D V-D VI	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Safety Sys Safety Sys Safety Sys	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s umentatior \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$5.00 \$5.00 \$7.00 \$12.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$0.00	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$13.09 \$22.44	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$21.00 \$0.00 \$0.00 \$0.00 \$10.00 \$10.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85 \$0.00 \$25.55 \$0.00 \$25.55	\$1.87 \$0.87 \$1.05 \$13.05 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00
	IV IV-A IV-B IV-C V-A V-B V-C V-D	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Safety Sys Coldbox H Materials 1	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s umentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	### SUIT SUIT SUIT SUIT SUIT SUIT SUIT SUIT	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$0.00 \$3.00 \$3.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$1.00 \$12.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$13.09 \$22.44	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$22.00 \$0.00 \$0.00 \$0.00 \$10.00 \$10.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85  \$0.00 \$0.00 \$25.55 \$0.00 \$25.55	\$1.87 \$0.00 \$13.05 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00
	IV IV-A IV-B IV-C V-A V-A V-C V-D V-D VI	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Safety Sys Safety Sys Safety Sys	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s umentatior \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$3.00 \$3.00 \$4.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$5.00 \$5.00 \$7.00 \$12.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41 \$4.41	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$9.35 \$0.00 \$13.09 \$22.44	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$0.00 \$0.00 \$0.00 \$10.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85 \$0.00 \$25.55 \$0.00 \$25.55	\$1.87 \$0.00 \$13.09 \$13.09 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00
	IV IV-A IV-B IV-C V-A V-B V-C V-D	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Safety Sys Coldbox H Materials 1	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s umentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	### SUIT SUIT SUIT SUIT SUIT SUIT SUIT SUIT	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$0.00 \$3.00 \$3.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$1.00 \$12.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$13.09 \$22.44	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$22.00 \$0.00 \$0.00 \$0.00 \$10.00 \$10.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85  \$0.00 \$0.00 \$25.55 \$0.00 \$25.55	\$1.87 \$0.00 \$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00
	IV IV-A IV-B IV-C V-D VI-A VI-B VI-C VI-C VI-C VI-C VI-C VI-C VI-C VI-C	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Coldbox H Materials I Install Lew Modify Pip	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00  x Modificat \$0.00 \$0.00 \$0.00	Labor   Cost K\$'s   Cost K\$'	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$0.00 \$3.00 \$3.00 \$4.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$5.00 \$5.00 \$7.00 \$12.00 \$3.00 \$3.00 \$3.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41 \$5.88 \$5.88	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$9.35 \$0.00 \$13.09 \$22.44	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$0.00 \$0.00 \$0.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$1.00 \$0.00 \$7.00 \$8.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	### Surdened Materials	\$1.85 \$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00
	IV   IV-A   IV-B   IV-C   V-A   V-B   V-C   V-D   VI-A   VI-B   VI-C   VI-D   VI-C   VI-D   V	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Safety Sys Safety Sys Safety Sys Coldbox H Materials Install Lew Modify Pip Provide Fil	Materials Cost K\$'s trols & Insti \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s umentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Eabor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$3.00 \$3.00 \$3.00 \$4.00 \$4.00 \$4.00 \$2.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41 \$5.88 \$5.88 \$5.88	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$9.35 \$0.00 \$13.09 \$22.44 \$0.00 \$5.61 \$7.48	Materials Cost K\$'s \$20.00 \$50.00 \$2.00 \$22.00 \$0.00 \$10.00 \$10.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85  \$0.00 \$25.55 \$0.00 \$25.55 \$0.00 \$0.00 \$0.00 \$0.00	\$1.87 \$0.00 \$1.87 \$0.00 \$13.05 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00
	IV IV-A IV-B IV-C V-D VI-A VI-B VI-C VI-C VI-C VI-C VI-C VI-C VI-C VI-C	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Coldbox H Materials 1 Install Lev Modify Pip Provide Fill Procure N	Materials Cost K\$'s trols & Insti (\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00  x Modificat \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor   Cost K\$'s   Cost K\$'	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$3.00 \$3.00 \$3.4.00 \$4.00 \$4.00 \$2.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$5.00 \$7.00 \$12.00 \$3.00 \$3.00 \$3.00 \$3.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41 \$5.88 \$5.88 \$2.94 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.35 \$0.00 \$13.09 \$22.44 \$0.00 \$5.61 \$7.48 \$5.61	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$0.00 \$10.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	### STATE	\$1.87 \$0.00 \$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00
	IV   IV-A   IV-B   IV-C   V-A   V-B   V-C   V-D   VI-A   VI-B   VI-C   VI-D   VI-C   VI-D   V	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Safety Sys Safety Sys Safety Sys Coldbox H Materials Install Lew Modify Pip Provide Fil	Materials Cost K\$'s trols & Insti (\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00  x Modificat \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s umentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Eabor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$3.00 \$3.00 \$3.00 \$4.00 \$4.00 \$4.00 \$2.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00 \$1.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41 \$5.88 \$5.88 \$5.88	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$9.35 \$0.00 \$13.09 \$22.44 \$0.00 \$5.61 \$7.48	Materials Cost K\$'s \$20.00 \$50.00 \$2.00 \$22.00 \$0.00 \$10.00 \$10.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor Cost K\$'s \$1.00 \$0.00 \$7.00 \$8.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85  \$0.00 \$25.55 \$0.00 \$25.55 \$0.00 \$0.00 \$0.00 \$0.00	\$1.87 \$0.00 \$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.0
	IV   IV-A   IV-B   IV-C   V-A   V-B   V-C   V-D   VI-A   VI-B   VI-C   VI-D   VI-C   VI-D   V	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Coldbox H Materials 1 Install Lev Modify Pip Provide Fill Procure N	Materials Cost K\$'s trols & Insti (\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00  x Modificat \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor   Cost K\$'s   Cost K\$'	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$3.00 \$3.00 \$3.4.00 \$4.00 \$4.00 \$2.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$5.00 \$7.00 \$12.00 \$3.00 \$3.00 \$3.00 \$3.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41 \$5.88 \$5.88 \$2.94 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.35 \$0.00 \$13.09 \$22.44 \$0.00 \$5.61 \$7.48 \$5.61	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$0.00 \$10.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	### STATE	\$1.87 \$0.00 \$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.0
	IV   IV-A   IV-B   IV-C   V-A   V-B   V-C   V-D   VI-A   VI-B   VI-C   VI-D   VI-C   VI-D   V	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Coldbox H Materials 1 Install Lev Modify Pip Provide Fill Procure N	Materials Cost K\$'s trols & Instit \$0.00	Labor Cost K\$'s umentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$0.00 \$3.00 \$4.00 \$4.00 \$4.00 \$4.00 \$5.00 \$5.00 \$5.00 \$5.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$12.00 \$12.00 \$12.00 \$12.00 \$10.00 \$10.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41 \$5.88 \$5.88 \$5.88 \$2.94 \$0.00 \$19.11	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.35 \$0.00 \$13.09 \$22.44 \$0.00 \$5.61 \$7.48 \$5.61	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$0.00 \$0.00 \$10.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Eabor Cost K\$'s \$1.00 \$0.00 \$7.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85 \$0.00 \$25.55 \$0.00 \$25.55 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$1.87 \$0.00 \$1.87 \$0.00 \$13.09 \$14.96 \$0.00 \$0.0
	IV   IV-A   IV-B   IV-C   V-A   V-B   V-C   V-D   VI-A   VI-B   VI-C   VI-D   VI-C   VI-D   V	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Coldbox H Materials 1 Install Lev Modify Pip Provide Fill Procure N	Materials Cost K\$'s trols & Insti (\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00  x Modificat \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Labor   Cost K\$'s   Cost K\$'	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$3.00 \$3.00 \$3.4.00 \$4.00 \$4.00 \$2.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$5.00 \$7.00 \$12.00 \$3.00 \$3.00 \$3.00 \$3.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$4.41 \$5.88 \$5.88 \$2.94 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.35 \$0.00 \$13.09 \$22.44 \$0.00 \$5.61 \$7.48 \$5.61	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$0.00 \$10.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	### STATE	Labor
	IV   IV-A   IV-B   IV-C   V-A   V-B   V-C   V-D   VI-A   VI-B   VI-C   VI-D   VI-C   VI-D   V	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Coldbox H Materials 1 Install Lev Modify Pip Provide Fill Procure N	Materials Cost K\$'s trols & Instit \$0.00	Labor Cost K\$'s umentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Eabor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$0.00 \$3.00 \$4.00 \$4.00 \$4.00 \$4.00 \$5.00 \$5.00 \$5.00 \$5.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$12.00 \$12.00 \$12.00 \$12.00 \$10.00 \$10.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$0.00 \$4.41 \$5.88 \$5.88 \$5.88 \$2.94 \$0.00 \$19.11	\$0.00 \$1.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$13.09 \$22.44 \$0.00 \$5.61 \$7.48 \$5.61 \$0.00 \$18.70	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$0.00 \$0.00 \$10.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Eabor Cost K\$'s \$1.00 \$0.00 \$7.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$2.55 \$0.00 \$2.76 \$53.85 \$0.00 \$25.55 \$0.00 \$25.55 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$1.87 \$0.00 \$1.87 \$0.00 \$13.05 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00
	IV   IV-A   IV-B   IV-C   V-A   V-B   V-C   V-D   VI-A   VI-B   VI-C   VI-D   VI-C   VI-D   V	Misc. Con Level & Pr PLC & I/O Equipment Misc. Con Safety Sys Stack Fire Stack Fire Safety Sys Safety Sys Coldbox H Materials 1 Install Lev Modify Pip Provide Fill Procure N	Materials Cost K\$'s trols & Instit \$0.00	Labor Cost K\$'s umentation \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Eabor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$3.00 \$3.00 \$3.00 \$4.00 \$4.00 \$4.00 \$5.00 \$5.00 \$5.00 \$5.00 \$5.00 \$5.00	Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$12.00 \$12.00 \$12.00 \$12.00 \$10.00 \$10.00	Burdened Materials Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$4.41 \$0.00 \$0.00 \$4.41 \$5.88 \$5.88 \$5.88 \$2.94 \$0.00 \$19.11	Burdened Labor Cost K\$'s \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$13.09 \$22.44 \$0.00 \$5.61 \$7.48 \$0.00 \$18.70	Materials Cost K\$'s \$20.00 \$0.00 \$2.00 \$2.00 \$0.00 \$0.00 \$10.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Eabor Cost K\$'s \$1.00 \$0.00 \$7.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Burdened Materials Cost K\$'s \$51.09 \$0.00 \$2.76 \$53.85 \$0.00 \$25.55 \$0.00 \$25.55 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	\$1.87 \$0.00 \$1.87 \$0.00 \$13.05 \$14.96 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00

### Case 1,2, Case 3 Cost Summary

	Cryogenic	s Phase I (0	Case 1 &2)									
	2 7 2 3 2											
	Fiscal	Year	2002		Fiscal	Year	2003		Fiscal	Year	2004	
			Burdened	Burdened			Burdened	Burdened			Burdened	Burdened
	Materials	Labor	Materials	Labor	Materials	Labor	Materials	Labor	Materials	Labor	Materials	Labor
	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s
Summary	\$0.00	\$16.50	\$47.00	\$30.86	\$50.00	\$38.00	\$73.50	\$71.06	\$22.00	\$8.00	\$53.85	\$14.96
Summary	TPC:											
Total Unbu	\$62.50		Burdened (	Cost with 2	0% Conting	ency By F	Ϋ́					
Total Burd	\$116.88			2002	2003	2004						
Total Unbu	\$72.00			\$93.43	\$173.47	\$82.57						
Total Burd	\$174.35											
Burdened <sup>†</sup>	\$291.23											
Burdened <sup>†</sup>	\$349.48											
	Cryogenic	l s Phase II (	Case 3)									
	Fiscal	Year	2002		Fiscal	Year	2003		Fiscal	Year	2004	
			Burdened	Burdened			Burdened	Burdened			Burdened	Burdened
	Materials	Labor	Materials	Labor	Materials	Labor	Materials	Labor	Materials	Labor	Materials	Labor
	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s	Cost K\$'s
Summary	\$40.00	\$21.50	\$47.00	\$40.21	\$59.00	\$69.50	\$86.73	\$129.97	\$102.00	\$8.00	\$182.30	\$14.96
Summary	L TPC:											
Total Unbu			Burdened (	Cost with 2	0% Conting	ency By F	Ϋ́					
Total Burde	\$185.14			2002								
Total Unbu	\$201.00			\$104.65	\$260.04	\$236.71						
Total Burde												
Burdened <sup>1</sup>	\$501.17											
Burdened <sup>1</sup>	\$601.40											