

U.S. NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

Submittal Documents Non-Proprietary Version

1. RR901-001-02, Revisions to Responses to RAI Part 3, Rev. A
2. CR Records: CR-2009-0623, -0624, -0625, -0628, -0631
3. DS901-000-75, HFC-6000 CPLD Design Specification, Rev. C
4. RR901-000-36, Radiation Exposure Evaluation, Rev. A



HF Controls



HF Controls

Revisions to Responses to NRC RAI Part 3

RR901-001-02

Rev. A

Effective Date: 3-19-10

Prepared By: Ivan Chow

Reviewed By: Charles McKinney

Approved By: Ed Herchenrader

Revisions to Responses to NRC RAI Part 3

Revision History

Date	Revision	Preparer	Changes
3/16/10	A	I. Chow	Initial Revision

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Revisions to Responses to NRC RAI Part 3

1.0 Introduction

This document contains the revisions to RR901-001-01, "(HFC) Responses to the NRC's Request for Additional Information (RAI) Part 3 Rev. A, in correspondence to the application of Doosan HF Controls (HFC) Corporation of HFC-6000 Safety System Topical Report, Revision C.

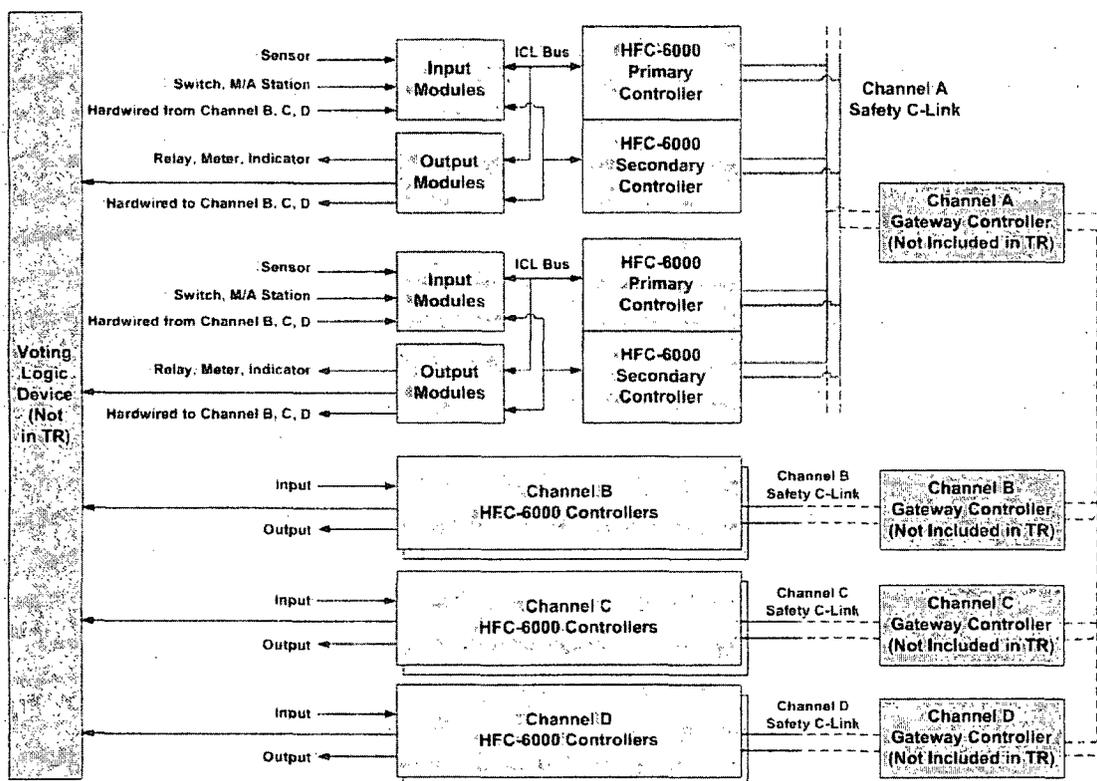
Section 2.0 lists the revisions to the specific RAI responses.

The supporting documents are listed in section 3.0.

2.0 Revisions to RAI Responses

RAI 118 Response

The following figure replaces figure 1 of RR901-001-01, "Responses to RAI Part 3", Rev. A.



Revisions to Responses to NRC RAI Part 3

RAI #121 Response

The following information is additional information to the response listed in RR901-001-01:

HFC part numbers for the commercial grade power supplies from Jasper Electronics are:

9044524Q for 600W 24V Power Supply

9044525Q for 600W 48V Power Supply

The followings are the supporting documents for dedicating these commercial grade items. The dedication process follows HFC quality process procedure QPP 7.2, "Commercial Grade Item Evaluation".

HFC Documentation
CGE 00074, HFC-6000 Power Supply (48V, 24V), Rev. A
TS901-000-22, ERD111, Baseline Testing Summary Report, Rev. B
Commercial / Industry References
Jasper Electronics Specification Sheet on HYL Type Power Supplies
EPRI TR 017218-R1, "Utilization of Sampling Guidelines for Commercial Grade Items"

RAI #127 Response

The following information is additional information to the response listed in RR901-001-01:

The operating modes are switch selectable (SW4-1&2). The normal operating mode is RUN. The four settings are:

RUN	Normal operating mode
SIMULATION	Offline application simulation mode
OFFLINE	Offline application loading mode
TEST	Offline diagnostic test mode

RAI #137 Response

The following information is additional information to the response listed in RR901-001-01:

RS901-000-37, "SC, SAP, SEP, VHDL Program Code Requirement", Rev. G, section 3.1.1.e states for the SC processor:

"The firmware shall initialize software structures for monitoring subordinate processors." This requirement includes setting configuration options for the subordinate processors and control of initialization sequence"

and section 3.3.1.c & d states for the SAP processor:

"The firmware shall also initialize particular software environment based on predefined configuration values for the processor. The firmware shall create data structures for storing the information."

Revisions to Responses to NRC RAI Part 3

"As a minimum, the firmware shall include all valid command codes and definitions for all message structures for the ICL protocol."

and section 3.4, paragraph 4 states:

"The UCP shall support communication between processors on the same controller board".

RAI #140 Response

The following information is additional information to the response listed in RR901-001-01:

[

]

RAI #152 Response

The following information is additional information to the response listed in RR901-001-01:

CR 2009-0623 to CR 2009-0626, CR 2009-0628, CR 2009-0630, and CR 2009-0631 were initiated by NRC during the December 2009 Audit. CR 2009-0627 and CR 2009-0629 were CR initiated by other activities during the NRC Audit time but they were not related to NRC audit activities.

CR #	Open Date	Issue
2009-0623	12/18/09	NRC
2009-0624	12/18/09	NRC
2009-0625	12/18/09	NRC
2009-0626	12/18/09	NRC
2009-0627	12/18/09	<i>Non NRC Related</i>
2009-0628	12/18/09	NRC
2009-0629	12/18/09	<i>Non NRC Related</i>
2009-0630	12/18/09	NRC
2009-0631	12/18/09	NRC

CR 2009-0627 and CR 2009-0629 are non-NRC related CRs.

Revisions to Responses to NRC RAI Part 3

RAI #165 Response

The first bullet point response shall be revised to "NO".

RAI #184 Response

The following information is additional information to the response listed in RR901-001-01:

Potential vulnerabilities:

[

]

Responses to RAI Part 3 from NRC for HFC-6000 Topical Report

3.0 List of Supporting Documents

The following table shows the list of supporting documents.

Document	Related RAI
CR Records: CR 2009-0623, CR 2009-0624, CR 2009-0625, CR 2009-0628, CR 2009-0631	152 & December 2009 Audit Report
DS901-000-75, HFC-SBC06 CPLD Design Specification, Rev. C	125
RR901-000-36, Radiation Exposure Evaluation	164, 166



HF Controls

Corrective Action Requested By NRC

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October 2009

Tab#	CR#	Opened	Closed
1	2009-0537	10/06/2009	11/17/2009
2	2009-0538	10/06/2009	11/09/2009
3	2009-0539	10/06/2009	11/23/2009
4	2009-0540	10/08/2009	11/19/2009
5	2009-0543	10/12/2009	12/15/2009

December 2009

Tab#	CR#	Opened	Closed
6	2009-0623	12/18/09	1/25/10
7	2009-0624	12/18/09	3/16/10
8	2009-0625	12/18/09	2/2/10
9	2009-0626	12/18/09	Open
10	2009-0628	12/18/09	3/18/10
11	2009-0630	12/18/09	Open
12	2009-0631	12/18/09	2/1/10

INFORMATION
ONLY

HF Controls

Condition Report

CR No: 2009-0623

Section I:

Initiator: Ed Herchenrader

Feedback:

Phone Number: x6568

Date: 12/18/2009

Department: Quality

Customer/Vendor: N/A

Project Number: ERD111

Time of Discovery: N/A

Part #: N/A

Procedure #: N/A

Other:

Section II: Condition Description / Finding (Attach additional sheets as required): Qty. of Items: _____

During the December NRC Audit it was noted that the following information should be changed/added.

RS901-000-37 Rev E Section 3.1.4.c states that the "STATUS" of the application shall be mirrored from the Primary to the Secondary. The issue is , the Design and Test documents detail what is transferred or 'mirrored' but this doc. only states "STATUS". Correction is to develop a better description of what is mirrored in the RS section.

Immediate Action Taken:

Recommended Action:

Section III: Assignment

Assigned Department Manager:

Category:

Date:

Due Date:

Keyword:

Trend Code:

QPP 16.1 Rev G:

Material Dispostion Required

Yes

Fast Track MDF

Section IV: Response

Investigation Results /Disposition / Root Cause:

10 CFR Part 21: Yes No N/A:

Section V: Corrective Action Plan (Enter Department Responsible and Due Date for each action):

Preparer:	Date:	Management Approval	Date:
Section VI: Closure: Verifier's Initials:	Date:	Results: ____ Pass ____ Fail	
Audit Fail Details:		____ Date Return to Administrator	
Administrator Notes:	Close Date:	Administrator Initials:	QA Mgr. Approval Date:

HF Controls

Condition Report

CR No: 2009-0624

Section I:

Initiator: Ed Herchenrader

Feedback:

Phone Number: x6568

Date: 12/18/2009

Department: Quality

Customer/Vendor: N/A

Project Number: ERD111

Time of Discovery: N/A

Part #: N/A

Procedure #: N/A

Other:

Section II: Condition Description / Finding (Attach additional sheets as required): Qty. of Items: _____

During the initial stress testing, there were analog input pcb's installed into the test chassis that had not been calibrated. This CR is to determine what actions HFC is taking to insure that this type of error is prevented in the future. What are we doing to insure all parts/software released for test or customer use is completely tested and verified.

Immediate Action Taken:**Recommended Action:****Section III: Assignment**

Assigned Department Manager:

Category:

Date:

Due Date:

Keyword:

Trend Code:

QPP 16.1 Rev G:

Material Disposition Required

Yes

Fast Track MDF

ATTACHMENT 7.2

CORRECTIVE ACTION IMPLEMENTATION FORM

CR NO.: 2009-0624			
Page ____ of ____			
CORRECTIVE ACTION #1 IMPLEMENTATION FORM			
ASSIGNED DEPARTMENT / INDIVIDUAL: _____			
Required Action and Estimated Completion Date: _____			
Prepared By: _____	Date: _____		
Indicate The Action Taken:			
Completed By: _____	Date: _____	Management Approval: _____	Date: _____

Section IV: Response

Investigation Results /Disposition / Root Cause:

10 CFR Part 21: Yes No N/A:

Section V: Corrective Action Plan (Enter Department Responsible and Due Date for each action):

Preparer:	Date:	Management Approval	Date:
Section VI: Closure:			
Verifier's Initials:	Date:	Results: _____ Pass _____ Fail	
Audit Fail Details:		_____ Date Return to Administrator	
Administrator Notes:	Close Date:	Administrator Initials:	QA Mgr. Approval Date:

HF Controls

Condition Report

CR No: 2009-0625

Section I:

Initiator: Ed Herchenrader

Feedback:

Phone Number: x6568

Date: 12/18/2009

Department: Quality

Customer/Vendor: N/A

Project Number: ERD111

Time of Discovery: N/A

Part #: N/A

Procedure #: N/A

Other:

Section II: Condition Description / Finding (Attach additional sheets as required): Qty. of Items: _____

During the December NRC Audit it was found that TS901-000-02 section 5.4, 5.5 need additional test to verify firmware transfer from PROM to Flash. The Test doc. was not specific as to the test action vs items under test. Did the test results clearly define and state that the requirements were met?

Immediate Action Taken:

Recommended Action:

Section III: Assignment

Assigned Department Manager:

Category:

Date:

Due Date:

Keyword:

Trend Code:

QPP 16.1 Rev G:

Material Disposition Required

Yes

Fast Track MDF

Section IV: Response

Investigation Results /Disposition / Root Cause:

10 CFR Part 21: Yes No N/A:

Section V: Corrective Action Plan (Enter Department Responsible and Due Date for each action):

Preparer:	Date:	Management Approval	Date:
Section VI: Closure: Verifier's Initials:	Date:	Results: _____ Pass _____ Fail	
Audit Fail Details:	_____ Date Return to Administrator		
Administrator Notes:	Close Date:	Administrator Initials:	QA Mgr. Approval Date:

HF Controls

Condition Report

CR No: 2009-0628

Section I:

Initiator: Ed Herchenrader

Feedback:

Phone Number: x6568

Date: 12/18/2009

Department: Quality

Customer/Vendor: N/A

Project Number: ERD111

Time of Discovery: N/A

Part #: N/A

Procedure #: N/A

Other:

Section II: Condition Description / Finding (Attach additional sheets as required): Qty. of Items: _____

During the December NRC audit it was determined that in TS002-000-01 Rev A., the intention of the test was to perform a ICL test to each I/O card type (as stated in the Topical Report). Test results are found for all card types except AI8M. Why? And was AI8M tested? If so, where is record of test. If not tested .why?

Immediate Action Taken:

Recommended Action:

Section III: Assignment

Assigned Department Manager:

Category:

Date:

Due Date:

Keyword:

Trend Code:

QPP 16.1 Rev G:

Material Disposition Required

Yes

Fast Track MDF

Section IV: Response

Investigation Results /Disposition / Root Cause:

10 CFR Part 21: Yes No N/A:

Section V: Corrective Action Plan (Enter Department Responsible and Due Date for each action):

Preparer:	Date:	Management Approval	Date:
Section VI: Closure:			
Verifier's Initials:	Date:	Results: ___ Pass ___ Fail	
Audit Fail Details:		___ Date Return to Administrator	
Administrator Notes:	Close Date:	Administrator Initials:	QA Mgr. Approval Date:

HF Controls

Condition Report

CR No: 2009-0631

Section I:

Initiator: Ed Herchenrader

Feedback:

Phone Number: x6568

Date: 12/18/2009

Department: Quality

Customer/Vendor: N/A

Project Number: ERD111

Time of Discovery: N/A

Part #: N/A

Procedure #: N/A

Other:

Section II: Condition Description / Finding (Attach additional sheets as required): Qty. of Items: _____

During the December NRC audit it was discussed that HFC may want to review and revise all design specifications of the operating system as they should be traceable back to the requirement and forward to a test case, e.g. functions such as WAIT, FORGO, RELINQ.

Immediate Action Taken:**Recommended Action:****Section III: Assignment**

Assigned Department Manager:

Category:

Date:

Due Date:

Keyword:

Trend Code:

QPP 16.1 Rev G:

Material Disposition Required

Yes

Fast Track MDF

Section IV: Response

Investigation Results /Disposition / Root Cause:

10 CFR Part 21: Yes No N/A:

Section V: Corrective Action Plan (Enter Department Responsible and Due Date for each action):

Preparer:	Date:	Management Approval	Date:
Section VI: Closure:			
Verifier's Initials:	Date:	Results: _____ Pass _____ Fail	
Audit Fail Details:		_____ Date Return to Administrator	
Administrator Notes:	Close Date:	Administrator Initials:	QA Mgr. Approval Date:



Information ONLY

HF CONTROLS CONTROL SYSTEM

HFC-6000 Product Line Components

HFC-SBC06 and HFC-DPM06

CPLD Design Specification

DS901-000-75

Rev C

Effective Date 12/10/2009
Author William Luo
Reviewer Gregory Morten
Approval Terrence A. Gerardis

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Revision History

Date	Revision	Author	Changes
11/4/09	A	W. Luo	Initial Release
12/1/09	B	W. Luo	SCR2620
12/10/09	C	W. Luo	SCR2620 and CR2009-621

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1.0 SCOPE

The HFC-SBC06, Rev. B, uses 4 CPLD designs to support Multi BUS I type of public device access among three processors. The HFC-SBC06 contains System Controller (SC), C-Link Processor (SEP), and ICL Processor (SAP). Four CPLD designs are functionally named as follow:

- SBC6_CHSEL: U36, 9093075-10.
- SBC_386C: U28, 9093074-10.
- SBC6_SHARB: U29, 9093076-10.
- PUBIF: U41, 9093073-10.

The HFC-DPM06, Rev. B, uses a CPLD design to support controller board DIP switch configuration setup and failover control logic. The SBC6_DPM, U6 9093077-10, implements these two functions.

This document addresses each of the above CPLD designs. The design is implemented using VHDL.

2.0 REFERENCES

DS901-000-01 SBC06_DPM06, Module Detailed Design Spec, Rev C
RS901-000-37 SC, SAP, SEP, DPM Firmware Requirement Spec, Rev D
40041801 HFC-SBC06 Schematic, Rev A
Embedded Pentium Processor Family Developer's Manual

2.1 SPECIAL TERMS AND ABBREVIATIONS

CPLD Complex Programmable Logic Device
NIC Network Interface Controller
VHDL VHSIC Hardware Description Language
VHSIC Very-High-Speed Integrated Circuit
DPM Dual-Port Memory
SOE Sequence Of Event

3.0 TECHNICAL DESIGN

3.1 MODULE ARCHITECTURE

The HFC-SBC06 uses four CPLD chips, as well as their interconnections, in HFC-SBC06 Rev B. They perform the memory access control, LED control, common device arbitration for three processors on-board.



3.2 SC ACCESS CONTROL

3.2.1 I/O Access Control– SBC6_CHSEL (U36)

The SBC6_CHSEL implements System processor I/O mapping logic and code flash chip select address decoding logic. The on-board DIP switch status is captured by the SBC6_CHSEL module. The System processor can also write working status or error codes to LEDs through SBC6_CHSEL.

3.2.1.1 Module Interface:

[



]

3.2.1.4 I/O Port F490_H – Memory Control and Status Port

[

]

Data Line	Function
0	
1	
2	
3	
4	
6	
7	

Table 2: Write Function for F490_H

[

]

Data Line	Signal
0	
1	
2	
3	
4	
7	

Table 3: Status Port



3.2.1.5 [] – Watchdog Timer Port

[

]

3.2.1.6 [] – Maintenance Failover Enable/Disable Port

[

]

3.2.1.7 [] – Public Memory Control Port

[

]

3.2.1.8 10 ms CPU Time Interrupt Generator

[

]

3.2.2 Public Memory BUS Access Control – PBUSIF (U41)

The PBUSIF_L converts Pentium CPU bus timing to be compatible with asynchronous SRAM timing and access logic.

3.2.2.1 Module Interface

[

]

3.2.2.2 Detail Design

[

]

3.3 SAP & SEP BUS ACCESS CONTROL – SBC_386C (U28)

[

]

3.3.1 Module Interface:

[



]

3.3.2 Detail Design

3.3.2.1 NIC Chip Access Control

[

]

Description	NIC 0	NIC 1
Low Byte Enable		
Upper Byte Enable		
Chip Enable		
Output Enable		
Read/Write Enable		

Table 4: NIC-DPM Control Signals

3.3.2.2 MultiBus Access Control

[

]

3.3.2.3 Reset Logic

[

]



3.4 MULTIBUS ARBITRATION – SBC6_SHARB (U49)

[

]

3.4.1 Module Interface:

[

]

3.4.2 Detail Design

The SBC6_SHARB is designed to support two major functions: the SOE Timer and the CPU bus arbiter.

3.4.2.1 SOE Timer

[

]



3.4.2.2 Multi CPU Bus Arbitration

[

]

3.5 SBC6_DPM DESIGN

The CPLD in HFC-DPM06 is designed to implement DIP switches read buffer control logic, and fail-over control logic.

3.5.1 Interface

[

]



3.5.2 Detail Design

The SBC6_DPM implements three major functions: DIP switch status read buffer control, controller fail over logic, and status display.

[

]





HF Controls

HFC-6000

Radiation Exposure Evaluation

Document No: RR901-000-36 Revision: A

Effective Date: 11/12/2009

Prepared By: Gregory Morton

Reviewed By: Charles McKinney

Approved By: Ivan Chow

[]

**Radiation Exposure Evaluation
HFC-6000**

Revision History

Date	Revision	Author	Changes
11/12/09	A	G. Morton	Initial version.

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Radiation Exposure Evaluation HFC-6000

1.0 PURPOSE AND SCOPE

- 1.1. The purpose of this document is to summarize the results from the radiation exposure analysis performed for the HFC-6000. EPRI TR-107330, section 4.3.6.3, requires an evaluation of a PLC platform to provide confidence that the system can withstand a minimum of 1 kRAD of radiation and continue operating.
- 1.2. The radiation exposure analysis was performed on the HFC-6000 system components listed in Table 1-1 of the HFC Topical Report submitted to the NRC.

2.0 REFERENCES

- 2.1. PP901-000-01, Rev C, HFC-6000 Topical Report
- 2.2. EPRI TR-107330 Final Report, December 1996

3.0 GENERAL INFORMATION

3.1. Approach

TR-107330, section 4.3.6.3, requires an evaluation to provide confidence that a PLC platform is capable of withstanding up to 1 kRAD of radiation exposure and remain operating. The following steps were taken to perform this evaluation for the HFC-6000:

1. The individual BOMs for the boards identified in Table 1-1 of the topical report were concatenated into a single text file
2. The "BOM" text file was imported into an Excel spreadsheet to create a table of individual components by HFC part number
3. Each component was classified into one of the following categories
 - SEMI – semiconductor
 - H/W – hardware
 - OSC – oscillator
 - RES – resistor
 - CAP – capacitor
4. A search was done to find a radiation test report or paper for every semiconductor component, or in most cases, for a similar component

Since numerous papers on the effects of radiation exposure all focused on semiconductor devices, the HFC-6000 radiation exposure analysis also focused on semiconductor-based components. The following three sources provided most of the radiation exposure test reports and papers:

[

Radiation Exposure Evaluation HFC-6000

]

3.2. Acronyms

BOM	Bill of Materials
ESA	European Space Agency
GSFC	Goddard Space Flight Center
JPL	Jet Propulsion Laboratory
NRC	Nuclear Regulatory Commission
RAD	Radiation Absorbed Dose

4.0 RESULTS

Attachment 5.1, Component Radiation Exposure Limits, contains the results of the radiation exposure evaluation for the HFC-6000 system. The radiation exposure limits for the components in the HFC-6000 system range from a minimum of 2.5 kRADS to 300 kRADS. Since the weakest component in the system can withstand 2.5 times the 1kRADs required in sections 4.3.6.1 and 4.3.6.2 of EPRI TR-107330, the HFC-6000 system as a whole should be able to withstand 1kRAD and still operate normally.

All radiation test reports referenced by Attachment 5.1 can be found under the following directory:

[

]

5.0 ATTACHMENTS

5.1. Attachment 5.1, "Component Radiation Exposure Limits"

**Radiation Exposure Evaluation
HFC-6000**

Attachment 5.1

Component Radiation Exposure Limits

HF Controls Part Number	Description	Mfg. P/N	Comparison Device	kRads(Silicon)	Radiation Test Report (*.pdf)
7868801					
7956240					
7956042					
7610754					
7648107					
7669740					
7669750					
7802327					
7802329					
7910801					
7932526					
7909802					
7868804					
7868809					
7077112					
7654202					
7799310					
7800602					
7909101					
7910920					
7910921					
7910925					
7932523					
7642035					

**Radiation Exposure Evaluation
HFC-6000**

HF Controls Part Number	Description	Mfg. P/N	Comparison Device	kRads(Silicon)	Radiation Test Report (* .pdf)
7642060					
7645102					
7672013					
7698210					
7909803					
7910101					
7910102					
7928506					
909307310					
909307410					
909307510					
909307610					
909307710					
912067614					
912067714					
912067814					
912067916					
912068017					
912068214					
912068312					
912068614					
7911001					
7640102					
7698203					
7698206					
7909130					
7909140					
7911002					
7642008					

**Radiation Exposure Evaluation
HFC-6000**

HF Controls Part Number	Description	Mfg. P/N	Comparison Device	kRads(Silicon)	Radiation Test Report (* .pdf)
7802302					
7911803					
7911815					
7911819					
7194705					
7931750					
7973202					
7942340					
7672004					
7672008					
7831306					
7672050					
7672051					
7026302					
7026308					
7055801					
7067000					
7077102					
7138201					
7164218					
7164252					
7164303					
7164304					
7164308					
7164312					
7164318					
7164319					
7164330					
7164340					
7164385					
7164410					

Radiation Exposure Evaluation
HFC-6000

HF Controls Part Number	Description	Mfg. P/N	Comparison Device	kRads(Silicon)	Radiation Test Report (*.pdf)
7609002					
7615205					
7645005					
7730901					
7748401					
7799400					
7909601					
7910402					
7910403					
7946703					
7946753					
7909150					
7914507					
7914508					
7057100					
7669604					
7772307					
7819605					
7853003					
7910404					