Target Station Shielding System Verification Plan

Project	Second Target Station
Part/Assembly	Target Station Shielding
WBS:	S.03.07
Lead Engineer:	Chris Anton

Requirement	Item ID	Description	PDR	FDR	FAT	Installation Test	Integrated System Test
Hydrogen Transfer Line Welding Access	8052	Target Station Shielding shall provide access for welding of the hydrogen transfer line during facility construction per Interface Sheet S03000000~-IST10011.		8065			
Core Vessel Drain Line Clearance	7815	Target Station Shielding shall provide clearance around the Core Vessel drain line per Interface Sheet S03000000~-IST10005	7836	7836			
Target Viewing Periscope Clearance	7813	Target Station Shielding shall provide appropriate clearance around the Target Viewing Periscope assembly per Interface Sheet S01020500~-IST10217	7837	7837			
Instrumentation Wire Pipe Chase	7411	Target Station Shielding shall provide a pipe chase through the bulk shielding for instrumentation wiring per Interface Sheet S01020500~-IST10220	7679	7679			
Pipe Pan Side Wall Penetrations	7410	Target Station Shielding shall provide penetrations in the pipe pan side wall for instrumentation wiring per Interface Sheet S01020500~-IST10220	7678	7678			
Concrete Temperature	7236	Target Station Shielding shall ensure that the monolith concrete temperature does not exceed 65 C for prolonged periods due to radiation heating per Interface Sheet S01020500~-IST10064	7677	7677			
Monolith Port Geometry	7235	Target Station Shielding shall supply the required interior profile of the monolith ports per Interface Sheet S01020500~-IST10064	7676	7676			
Grout Holes	7234	Target Station Shielding shall include features that allow grouting of Target Station Shielding hardware per Interface Sheet S01020500~-IST10064	7675	7675			
Mechanical Loading Details	7233	Target Station Shielding shall supply the mechanical loads imparted on the concrete by the monolith interior components per Interface Sheet S01020500~-IST10064	7673	7673			
Concrete Anchor Details	7232	Target Station Shielding shall supply the location~, size~, connection type and mechanical loading of the concrete anchors required by Target Station Shielding per Interface Sheet S01020500~-IST10064	7672	7672			
Monolith internal concrete profile	7230	Target Station Shielding shall supply the required monolith internal concrete profile to Conventional Facilities per Interface Sheet S01020500~-IST10064	7671	7671			
Monolith Port Clearance	7228	Target Station Shielding shall provide appropriate physical clearance between the monolith insert rear flanges~, utility connections and the monolith ports per Interface Sheet S01020500~-IS0025	7670	7670			
Removable Component Lifting Interfaces	7225	Target Station Shielding shall provide lifting interfaces for all removable Target Station Shielding components per Interface Sheet S03000000~-IST10007	7669	7669			
Target Water Line Support	7223	Target Station Shielding shall support target water line support assemblies per Interface Sheet S03000000~-IST10005	7668	7668			
Bulk Shielding Liner Drain	7222	Target Station Shielding shall provide a connection pipe to the bulk shielding liner drain per Interface Sheet S03000000~-IST10005	7667	7667			
Utility Pipe Clearance	7221	Target Station Shielding shall allow for utility pipes to pass through the pipe pan covers into the target drive room per Interface Sheet S03000000~-IST10005	7666	7666			
Utility Pipe Access	7220	Target Station Shielding shall allow for access to the utility pipes contained within the pipe pan per Interface Sheet S03000000~-IST10005	7665	7665			
Pipe Pan Pipe Supports	7219	Target Station Shielding shall provide features within the pipe pan for mounting of pipe supports designed and provided by Process Systems per Interface Sheet S03000000~-IST10005	7664	7664			
Pipe Pan Drainage	7218	Target Station Shielding shall slope the bottom of the pipe pan a minimum of 1 degree downward slope towards the hot process vault and provide an interfacing feature for water routing to the leak collection system per Interface Sheet S03000000~-IST10005	7663	7663			
Utility Pipe Clearance	7217	Target Station Shielding shall supply sufficient clearance for utility piping inside the pipe pan per Interface Sheet S03000000~-IST10005	7662	7662			
Proton Beam Tube Assembly Clearance	7215	Target Station Shielding shall provide clearance in the bulk shielding liner for the Proton Beam Tube Assembly per Interface Sheet S01020500~-IST10217	7661	7661			
Proton Beam Tube Assembly Remote Clamp Access	7214	Target Station Shielding shall allow access to the Proton Beam Tube Assembly remote clamp within 24 hours per Interface Sheet S01020500~-IST10217 Note: The clock starts when the removable shielding removal above the Proton Beam Tube Assembly begins	7660	7660			
Utility Line Clearance	7213	Target Station Shielding shall provide clearance for the Proton Beam Window and Proton Beam Window Shielding utility lines per Interface Sheet S01020500~-IST10217	7659	7659			
Proton Beam Window Shielding Access	7212	Target Station Shielding shall allow access to the Proton Beam Window Shielding Assembly within 24 hours per Interface Sheet S01020500~-IST10217 Note: The clock starts when the removable shielding removal above the PBW Shielding assembly begins	7838	7838			7839
Proton Beam Window Access	7211	Target Station Shielding shall allow access to the Proton Beam Window within 8 hours per Interface Sheet S01020500~-IST10217 Note: The clock starts when the removable shielding removal above the PBW begins	7657	7657			7658
AIC Support	7207	Target Station Shielding shall align and support the baseplate that the Proton Beam Window~, Proton Beam Window Shielding and Proton Beam Tube Assembly remote clamp are mounted to. Gravitational and seismic loads will be supported while maintaining the alignment tolerances specified in Interface Sheet S01020500~-IST10217.	7653	7653			
Transfer Line Support Features	7204	Target Station Shielding shall provide features in the pipe pan for mounting of transfer line supports per Interface Sheet S03000000~-IST10011.	7652	7652			
Transfer Line Drop Damage Protection	7203	Target Station Shielding shall provide removable covers above the hydrogen transfer line to protect it from damage due to falling objects within the target drive room per Interface Sheet S03000000~-IST10011.	7651	7651			
Transfer Line Seismic Protection	7202	Target Station Shielding shall prohibit the pipe pan from damaging the hydrogen transfer line during a seismic event per Interface Sheet S03000000~-IST10011.	7729	7729			

Transfer line Clearance	7201	Target Station Shielding shall provide an unobstructed path through the pipe pan for the hydrogen transfer line per Interface Sheet S03000000~-IST10011.	7650	7650
Target Protection during LOCA	6987	Target Station Shielding hardware shall assist in keeping the target temperature below 800C under loss of cooling event. %%(color:rgb(0, 0, 0);)\\ ''Note: The shielding acts as a thermal sink that helps maintain target temperatures of < 800 C during a loss of cooling event''%! \\ ''PHAR References:'' ''BG7~-8~, BG7~-9A~, BG7~-12~, CMS7~-1~, CMS7~-3~, CMS7~-5~, TS3~-2~, TS3~-3~, TS3~-5~, TS3~-6~, TS3~-7''	7645	7645
Radiation Shielding Performance	6986	Target Station Shielding~, along with the other Target Systems components in the Monolith and Target Drive Room~, shall not prevent necessary operations in the high bay due to radiation dose. \\ ''PHAR References:'' ''%%(color:rgb(226, 80, 65);)VS4~-1 (Credited)%!''	7644	7644
Shielding Anchoring	6984	The Target Station Shielding shall be anchored in such a way to limit motion of the bulk shielding relative to the monolith floor or relative to different shielding layers to < 0.1 mm under SDC Level 2 seismic loads. \\ ''PHAR References:'' ''AIC7~-11~, BG7~-2~, BG7~-12~, CMS7~-1~, CMS7~-3~, HPV3~-4B''	7641	7641
Protect Cryogenic Transfer Lines	6983	Target Station Shielding shall not permit motion of the shielding to cause the cryogenic transfer lines to release Hydrogen under SDC2 seismic conditions. \\ ''PHAR References:'' ''AIC7~-1~, %%(color:rgb(226, 80, 65);)BG6~-9 (Credited)%!~, %%(color:rgb(226, 80, 65);)BG7~-1A (Credited)%!~, BG7~-2~, BG7~-11~, BG7~-12~, CMS7~-1~, CMS7~-5''	7640	7640
Non-Flammable Shielding	6982	Target Station Shielding components shall be made of non~-flammable materials. \\ ''PHAR References:'' BG1~-1~, BG6~-9~, %%(color:rgb(226, 80, 65);)BG6~-9 (Credited)%!~, BG7~-1A~, BG7~-11	7639	7639
Pipe Pan Drain	6980	Pipe Pans shall capture water leaks in the Target Drive Room and drain to a connected leak collection system. \\ ''PHAR References:'' ''CMS1~-4~, CMS2~-5~, LCS1~-1~, LCS2~-1~, LCS3~-1~, LCS3~-2~, LCS3~-3~, LCS4~-1~, VS3~-1''	7649	7649
Bulk Shielding Liner Leak Collection	6979	A bulk shielding liner shall capture water leaks at the bottom of the Monolith and drain to a connected leak collection system. \\ ''PHAR References:'' ''CMS1~-4~, CMS2~-5~, LCS1~-1~, LCS2~-1~, LCS3~-1~, LCS3~-2~, LCS3~-3~, LCS4~-1~, VS3~-1''	7648	7648
Impact Damage Protection	6978	The Monolith steel shielding shall protect the Target Feet and Moderator Reflector Assembly from physical impact damage when installed and in the operational configuration. \\ Note: Target Station Shielding does not protect Moderator Reflector Assembly or Target feet that have been removed from their home positions within the monolith. Note: Target station shielding provides less protection when removable shielding is not in place during maintenance activities. \\ ''PHAR References:'' ''%%(color:rgb(226, 80, 65);)BG6~-9 (Credited)%!~, BG6~-10~, BG7~-4~, CMS2~-5''	7647	7647

Target Temperature Limit During Facility Fire	6977	Monolith shielding shall assist in keeping target temperature below 800C under reasonable fire conditions. \\ "PHAR References:" "BG1~-1~, %%(color:rgb(226, 80, 65);)BG6~-9 (Credited)%!~, BG7~-1A~, BG7~-11~, CMS7~-3~, CMS7~-5"	7646	7646
Carbon Steel Temperature Limit	6138	Target Station Shielding carbon steel structures should have a maximum operating temperature of 200 C	7638	7638

Test Cases and Test Steps

Item ID	Name	Test Steps.Action	Test Steps.Expected result	Verifies	Type	Phase
8065	Inspection - Hydrogen Transfer Line Welding Access	Review drawings of target station shielding.		[S.03.07-8052] - Hydrogen Transfer Line Welding Access	Inspection	FDR
		Does target station shielding provide access for welding of the hydrogen transfer line during facility construction per Interface Sheet S03000000~-IST10011?	Yes			
7839	Test - Proton Beam Window Shielding Access	Perform the operations necessary to access the proton beam window shielding on the mockup test stand.		[S.03.07-7212] - Proton Beam Window Shielding Access	Test	Integrated System Test
		Is the proton beam window shielding accessible within 8 hours of operation on the mockup test stand?	Yes			
7838	Analysis - Proton Beam Window Shielding Access	Perform a labor analysis of the operations necessary to access the PBW Shielding Assembly.		[S.03.07-7212] - Proton Beam Window Shielding Access	Analysis	PDR\,FDR
		Does the target station shielding allow access to the PBW Shielding Assembly within 24 hours per Interface Sheet S01020500~-IST10217?	Yes			
7837	Inspection - Target Viewing Periscope Clearance	Review drawings of the target station shielding.		[S.03.07-7813] - Target Viewing Periscope Clearance	Inspection	PDR\,FDR
		Does the target station shielding provide appropriate clearance around the TVP assembly per Interface Sheet S01020500~-IST10217?	Yes			
7836	Inspection - Core Vessel Drain Line Clearance	Review drawings of target station shielding		[S.03.07-7815] - Core Vessel Drain Line Clearance	Inspection	PDR\,FDR
		Does the target station shielding provide clearance around the Core Vessel drain line per Interface Sheet S03000000~-IST10005?	Yes			
7729	Analysis - Transfer Line Seismic Protection	Create a structural model of the target station shielding and pipe pan.		[S.03.07-7202] - Transfer Line Seismic Protection	Analysis	PDR\,FDR
		Does the target station shielding prohibit the pipe pan from damaging the hydrogen transfer line during a seismic event?	Yes			
7679	Inspection - Instrumentation Wire Pipe Chase	Review drawings of target station shielding.		[S.03.07-7411] - Instrumentation Wire Pipe Chase	Inspection	PDR\,FDR
		Does the target station shielding provide a pipe chase through the bulk shielding for instrumentation wiring per Interface Sheet S01020500~-IST10220?	Yes			
7678	Inspection - Pipe Pan Side Wall Penetrations	Review drawings of target station shielding.		[S.03.07-7410] - Pipe Pan Side Wall Penetrations	Inspection	PDR\,FDR
		Does the target station shielding provide penetrations in the pipe pan side wall for instrumentation wiring per Interface Sheet S01020500~-IST10220?	Yes			
7677	Analysis - Concrete Temperature	Create a thermal model of the monolith concrete.		[S.03.07-7236] - Concrete Temperature	Analysis	PDR\,FDR
		Does the monolith concrete temperature not exceed 65 degrees Celsius due to radiation heating?	Yes			
7676	Inspection - Monolith Port Geometry	Review drawings of target station shielding		[S.03.07-7235] - Monolith Port Geometry	Inspection	PDR\,FDR
		Does the target station shielding supply the required interior profile of the monolith ports per Interface Sheet S01020500~-IST10064.	Yes			
7675	Inspection - Grout Holes	Review drawings of the target station shielding.		[S.03.07-7234] - Grout Holes	Inspection	PDR\,FDR
		Does the target station shielding incorporate grout holes into all TSS hardware that is to be grouted in place?				
7673	Analysis - Mechanical Loading Details	Calculate the gravitational loads imparted on the concrete by the monolith interior components.		[S.03.07-7233] - Mechanical Loading Details	Analysis	PDR\,FDR
7672	Inspection - Concrete Anchor Details	Review drawings of target station shielding.		[S.03.07-7232] - Concrete Anchor Details	Inspection	PDR\,FDR
		Review interface sheet S01020500~-IST10064.				
		Does target station shielding supply the location~, size~, connection type~, and mechanical loading of the concrete anchors required by TSS?	Yes			
7671	Inspection - Monolith internal concrete profile	Review drawings of the target station shielding.		[S.03.07-7230] - Monolith internal concrete profile	Inspection	PDR\,FDR
		Does the target station shielding supply the required monolith internal concrete profile to CF?	Yes			
7670	Inspection - Monolith Port Clearance	Review drawings of the target station shielding/		[S.03.07-7228] - Monolith Port Clearance	Inspection	PDR\,FDR
		Does the target station shielding provide appropriate physical clearance between the monolith insert rear flanges~, utility connections~, and the monolith ports?	Yes			
7669	Inspection - Removable Component Lifting Interfaces	Review drawings of the target station shielding.		[S.03.07-7225] - Removable Component Lifting Interfaces	Inspection	PDR\,FDR
		Does target station shielding provide lifting interfaces for all removable target station shielding components?				

7668	Inspection - Target Water Line Support	Review drawings of the target station shielding.		[S.03.07-7223] - Target Water Line Support	Inspection	PDR\,FDR
		Does target station shielding support the target water line support assemblies?	Yes			
7667	Inspection - Bulk Shielding Liner Drain	Review drawings of the target station shielding.		[S.03.07-7222] - Bulk Shielding Liner Drain	Inspection	PDR\,FDR
		Does target station shielding provide a connection pipe to the bulk shielding liner drain?	Yes			
7666	Inspection - Utility Pipe Clearance	Review drawings of the target station shielding.		[S.03.07-7221] - Utility Pipe Clearance	Inspection	PDR\,FDR
		Does target station shielding allow for pipes to pass through the pipe pan covers into the target drive room?	Yes			
7665	Inspection - Utility Pipe Access	Review drawings of the target station shielding.		[S.03.07-7220] - Utility Pipe Access	Inspection	PDR\,FDR
		Does target station shielding allow for access to the utility pipes contained within the pipe pan?	Yes			
7664	Inspection - Pipe Pan Pipe Supports	Review drawings of the target station shielding.		[S.03.07-7219] - Pipe Pan Pipe Supports	Inspection	PDR\,FDR
		Does the target station shielding provide features within the pipe pan for mounting of pipe supports designed and provided by process systems?	Yes			
7663	Inspection - Pipe Pan Drainage	Review drawings of the target station shielding.		[S.03.07-7218] - Pipe Pan Drainage	Inspection	PDR\,FDR
		Does target station shielding have a 1°-degree downward slope in the pipe pan towards the hot process vault?	Yes			
		Does target station shielding provdie an interfacing feature for water routing to the leak collection system?	Yes			
7662	Inspection - Utility Pipe Clearance	Review drawings of target station shielding.		[S.03.07-7217] - Utility Pipe Clearance	Inspection	PDR\,FDR
		Does target station shielding supply sufficient clearance for utility piping inside the pipe pan per Interface Sheet S03000000~-IST10005?	Yes			
7661	Inspection - Proton Beam Tube Assembly Clearance	Review drawings of the target station shielding and bulk shielding liner		[S.03.07-7215] - Proton Beam Tube Assembly Clearance	Inspection	PDR\,FDR
		Does the target station shielding provide clearance in the bulk shielding for the PBTA?	Yes			
7660	Analysis - Proton Beam Tube Assembly Remote Clamp Access	Perform an estimate of how long it will take to gain access to the PBTA remote clamp.		[S.03.07-7214] - Proton Beam Tube Assembly Remote Clamp Access	Analysis	PDR\,FDR
		Is the PBTA remote clamp accessible within 8 hours of labor?	Yes			
7659	Inspection - Utility Line Clearance	Review drawings of the target station shielding.		[S.03.07-7213] - Utility Line Clearance	Inspection	PDR\,FDR
		Does the target station shielding provide clearance for the proton beam window and proton beam window shielding utility lines?	Yes			
7658	Test - Proton Beam Window Access	Perform the operations necessary to access the proton beam window on the mockup test stand.		[S.03.07-7211] - Proton Beam Window Access	Test	Integrated System Test
		Is the proton beam window accessible within 8 hours of operation on the mockup test stand?	Yes			
7657	Analysis - Proton Beam Window Access	Perform an estimate of how long it will take to gain access to the proton beam window by removing shielding.		[S.03.07-7211] - Proton Beam Window Access	Analysis	PDR\,FDR
		Is the proton beam window accessible within 8 hours of labor?	Yes			
7653	Analysis - Proton Beam Window Support	Create a structural model of the target station shielding supporting the proton beam window.		[S.03.07-7207] - AIC Support	Analysis	PDR\,FDR
		Does the target station shielding support the proton beam window under gravitational and seismic loads while maintaining the alignment tolerances specified in Interface Sheet S01020500~-IST10217?	Yes			
7652	Inspection - Transfer Line Support Features	Review the pipe pan design.		[S.03.07-7204] - Transfer Line Support Features	Inspection	PDR\,FDR
		Does the target station shielding provide features in the pipe pan for mounting of transfer line supports per Interface Sheet XXXXX.	Yes			
7651	Inspection - Transfer Line Drop Damage Protection	Review drawings of the target station shielding.		[S.03.07-7203] - Transfer Line Drop Damage Protection	Inspection	PDR\,FDR
		Does the target station shielding provide removable covers above the hydrogen transfer line to cover the lines?	Yes			
7650	Inspection - Transfer Line Clearance	Review drawings of target station shielding assembly and hydrogen transfer line.		[S.03.07-7201] - Transfer line Clearance	Inspection	PDR\,FDR
		Review interface sheet XXXXX between target station shielding and hydrogen transfer line				
		Does the target station shielding provide an unobstructed path through the pipe pan for the hydrogen transfer line per Interface Sheet XXXXX?	Yes			
7649	Inspection - Pipe Pan Drain	Review drawings of the target station shielding pipe pan.		[S.03.07-6980] - Pipe Pan Drain	Inspection	PDR\,FDR
		Review interface sheet between process systems and target station shielding				
		Does the target station shielding pipe pan capture water leaks in the Target Drive Room and drain to an agreed upon connection with process systems?	Yes			
7648	Inspection - Bulk Shielding Liner Leak Collection	Review drawings of the target station shielding.		[S.03.07-6979] - Bulk Shielding Liner Leak Collection	Inspection	PDR\,FDR
		Review interface sheet between process systems and target station shielding				
		Does target station shielding assembly have a bulk shielding liner that will capture water leaks at the bottom of the monolith and drain to an agreed upon connection with process systems?	Yes			

7647	Inspection - Impact Damage Protection	Review drawings of interface between the monolith steel shielding and the target wheel.		[S.03.07-6978] - Impact Damage Protection	Analysis	PDR\,FDR
		Does the monolith steel shielding protect the target wheel from physical impact damage?	Yes			
		Review drawings of interface between the monolith steel shielding and the MRA.				
		Does the monolith steel shielding protect the MRA from physical impact damage?	Yes			
7646	Analysis - Target Temperature Limit	Create a thermal model of target station shielding and core vessel components.		[S.03.07-6977] - Target Temperature Limit During Facility Fire	Analysis	PDR\,FDR
		Apply loads of reasonable fire conditions.				
		Does the target temperature remain below 800 degrees Celsius under reasonable fire conditions?	Yes			
7645	Analysis - Target Protection during LOCA	Create a thermal model of target station shielding and core vessel components.		[S.03.07-6987] - Target Protection during LOCA	Analysis	PDR\,FDR
		Simulate a loss of cooling event.				
		Does the target temperature remain below 800 degrees Celsius during a loss of cooling event?	Yes			
7644	Analysis - Radiation Shielding Performance	Create a neutronics model of the target station shielding~, along with the other target systems components in the monolith and target drive room.		[S.03.07-6986] - Radiation Shielding Performance	Analysis	PDR\,FDR
		Is the radiation dose attenuated to a level that allows general accessibility in the high bay?	Yes			
7641	Analysis - Shielding Anchoring	Create a structural model of the target station shielding and apply SDC2 seismic conditions.		[S.03.07-6984] - Shielding Anchoring	Analysis	PDR\,FDR
		Is the target station shielding secured such that the bulk station does not have motion relative to the monolith floor or relative to different shielding layers under SDC2 seismic conditions?	Yes			
7640	Analysis - Protect Cryogenic Transfer Lines	Create a structural model of the target station shielding and apply SDC2 seismic conditions.		[S.03.07-6983] - Protect Cryogenic Transfer Lines	Analysis	PDR\,FDR
		Is the target station shielding secured such that the target station shielding does not damage the CMS hydrogen transfer lines due to motion of the shielding under SDC2 seismic conditions?	Yes			
7639	Inspection - Non-Flammable Shielding	Create a list of all materials present in target station shielding.		[S.03.07-6982] - Non-Flammable Shielding	Inspection	PDR\,FDR
		Is the target station shielding made of non~-flammable materials?	Yes			
7638	Analysis - Carbon Steel Temperature Limit	Create a thermal model of the target station shielding carbon steel structures.		[S.03.07-6138] - Carbon Steel Temperature Limit	Analysis	PDR\,FDR
		Does the temperature of the target station shielding carbon steel structures have a maximum operating temperature of less than 200 degrees Celsius?	Yes			