

과제제안요구서

[스페이스파이오니어사업 세부과제]
“ 저장성 이원추진제 추력기 개발 ”

저장성 이원추진제 추력기 개발

□ 추진배경

- 제3차 우주개발진흥기본계획에 따라 정지궤도 관측, 통신(방송), 조기경보, 자료중계, 항법(경사) 등의 다양한 임무에 필요한 정지궤도 위성사업이 추진될 계획임
- 정지궤도위성은 위성자세제어와 전이궤도수행을 위해서 이원추진제 추력기와 액체 원지점엔진이 필수적임
- 연계 체계사업에서 요구하는 이원추진제 추력기의 성능 수준은 공칭 추력 10 N, 비추력 287 s 이상임

과제제안요구서(RFP)

연구과제명	저장성 이원추진제 추력기 개발		
1. 연구목표	10 N급 이원추진제(MMH*/NTO**) 추력기(QM) 개발		
성능 규격	해외선진국 성능수준 (평균치)	체계에서 요구하는 성능수준 (예상치)	개발목표
공칭 추력	10 N (ArianeGroup) 9 N (Moog)	≥ 9.8 N	9.9 ± 0.2 N
비추력	291 s (ArianeGroup) 274 s (Moog)	≥ 287 s	≥ 287 s
총연소시간 (정상상태+펄스모드)	70 hours (ArianeGroup)	50 hours	70 hours
○ 펄스모드의 성능수준 및 개발목표			
On-time (ms)	Off-time (ms)	lbit (mNs)	
5	≥ 2000	≤ 50	
7	≥ 2000	≤ 70	
*MMH: Monomethyl Hydrazine, **NTO: Nitrogen Tetroxide			
2. 연구내용 및 연구성과			
■ 연차별 연구 내용			
○ 1차년도			
- 10N급 이원추진제 추력기 개발 계획서, 규격 및 제작/조립/시험 문서 초안 작성			
- 10N급 이원추진제 추력기 설계 보완 및 예비 설계 및 해석			
- 10N급 이원추진제 추력기 제작/조립 및 연소시험장 구축 또는 보완 계획 수립 및 착수			
○ 2차년도			
- 10N급 이원추진제 추력기 상세 설계 및 해석			
- 절삭가공과 적층제조(금속 3D 프린팅) 복합공정 개발, 제작/조립 및 연소시험장 구축 또는 보완(계속)			
○ 3차년도			
- 10N급 이원추진제 추력기 EM 추력기 제작/조립/시험(연소시험 포함)			

- 절삭가공과 적층제조(금속 3D 프린팅) 복합공정 최적화
- 10N급 이원추진제 추력기 제작/조립 및 연소시험장 구축 또는 보완(계속)
- 4차년도
 - 10N급 이원추진제 추력기 QM 추력기 제작/조립/예비시험
 - 절삭가공과 적층제조(금속 3D 프린팅) 복합공정 표준화
 - 10N급 이원추진제 추력기 제작/조립 및 연소시험장 구축 또는 보완(계속)
- 5차년도
 - 10N급 이원추진제 추력기 QM 추력기 시험
 - 10N급 이원추진제 추력기 제작/조립 및 연소시험장 구축 또는 보완 완료 및 인증연소시험
- 시험검증 방법
 - 이원추진제 추력기 시험계획을 수립하고 각각의 부품시험절차서에 따라 검증시험을 수행함
 - 우주환경시험은 국내 시설 및 시험인력을 이용하여 진행할 예정임
- 최종성과물 및 활용 방안

최종성과물	목표 체계	성과활용방안
10N급 이원추진제 추력기(QM)	[최초 적용 체계] 10N급 이원추진제 추력기(QM)는 '29년 발사예정인 정지궤도 해양/환경위성 탑재 [이후 적용 체계] 우주검증이력이 확보되는 '28년 이후 모든정지궤도위성에 발사 3년 전까지 적용	[최초 적용 체계] '22년 정지궤도 해양/환경위성사업단을 통해 위성 상세설계에 개발사양 반영 정지궤도 해양/환경위성 제작에 들어가는 '26년 1/4분기까지 FM 제공(체계예산 편성필요) [이후 적용 체계] 상세설계에 개발성과를 반영하고, '28년 이후 모든 위성 제작시점에 FM제공 이원추진제 추력기 기술개발에서 개발한 공통기술(분사기 유동 해석 및 연소모델)을 동일한 추진제를 사용하는 400N급 액체원지점엔진 개발에 활용함

3. 특기사항

- 저장성 이원추진제 추력기의 연소실 진공수준은 0.5 mbar 시작, 5 mbar 유지임. (ArianeGroup(독일)의 연소시험장 기준)

4. 연구기간 및 연구비

- (연구기간) '21.5.~'25.12(5년)
- (연구비) 80.0억원 (중소기업 기관부담금 기준 19.9억원 포함)

(단위: 억원)

연차	1차년도	2차년도	3차년도	4차년도	5차년도	합계
연도	2021	2022	2023	2024	2025	
정부지원금	5.7	14.7	15.0	11.7	13.0	60.1
민간부담금	3.98	3.98	3.98	3.98	3.98	19.9
합계	9.68	18.68	18.98	15.68	16.98	80.0

※ 연구기간 및 연구비는 정부의 예산사정 및 평가결과 등에 따라 변동될 수 있음

제안 요청서

스페이스파이오니어사업 세부과제
저장성 이원추진제 추력기 개발

2021. 04.

스페이스파이오니어사업단

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제 1 장. 개요

본 제안요청서는 공모를 통하여 ‘저장성 이원추진제 추력기 개발’을 수행할 업체를 선정할 목적으로 작성한다.

제 1 절. 제안요청서의 구조

본 제안요청서는 제 2 장 ‘제안서 제출 요령’ 제 3 장 ‘기술적 요구사항’, 제 4 장 ‘기타 특수조건’ 및 특수조건 등이 요구하는 붙임의 양식 등을 포함하며, 제 2 장에서는 제안서 제출요령 및 사업관리 등 방안 등을, 제 3 장 및 제 4 장에서는 참여업체가 수행해야할 업무 및 조건 등을 정의한다.

제 2 절. 본 사업의 목표

가. 연구의 목표

10 N급 이원추진제(MMH/NTO) 추력기(QM, 이하 “RCT K10”) 개발

성능 규격	해외선진국 성능수준 (평균치)	체계에서 요구하는 성능수준 (예상치)	개발목표
공칭 추력	10 N (ArianeGroup) 9 N (Moog)	$\geq 9.8 \text{ N}$	$9.9 \pm 0.2 \text{ N}$
비추력	291 s (ArianeGroup) 274 s (Moog)	$\geq 287 \text{ s}$	$\geq 287 \text{ s}$
총연소시간	70 hours (ArianeGroup)	50 hours	70 hours

나. 최종 성과물 및 활용 체계

최종성과물	목표 체계	성과활용방안
10N급 이원 추진제 추력 기(QM)	[최초 적용 체계] 10N급 이원추진제 추력기(QM)는 '29년 발사예정인 해양/환경 정지궤도위성 탑재 [이후 적용 체계] 우주검증이력이 확보되는 '28년 이후 모든 정지궤도위성에 발사 3년 전까지 적용	[최초 적용 체계] '22년 해양/환경 정지궤도위성사업단을 통해 위성 상세설계에 개발사양 반영 해양/환경 정지궤도위성 제작에 들어가는 '26년 1/4분기까지 FM 제공(체계예산 편성필요) [이후 적용 체계] 상세설계에 개발성과를 반영하고, '28년 이후 모든 위성 제작시점에 FM제공 이원추진제 추력기 기술개발에서 개발한 공통기술(분사기 유동 해석 및 연소모델)을 동일한 추진제를 사용하는 400N급 액체원지점엔진 개발에 활용함

제 3 절. 주요 용어 및 약자

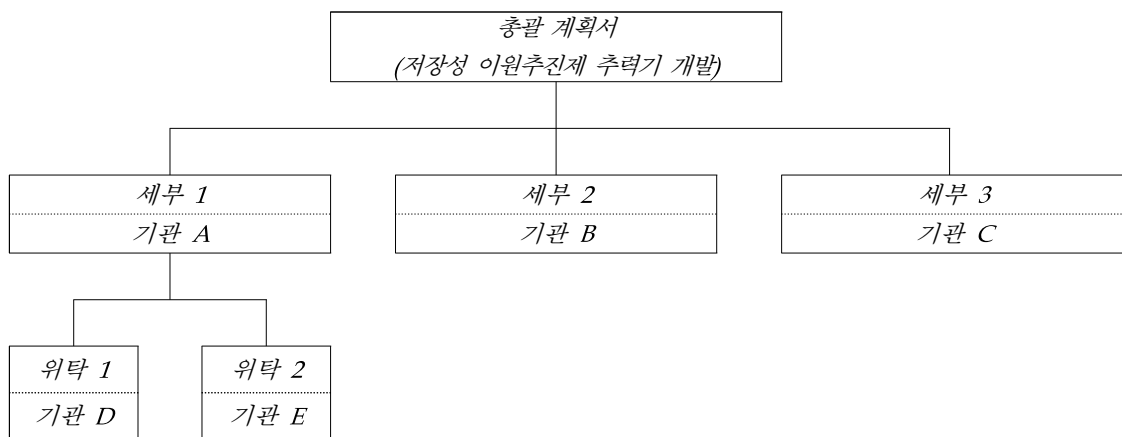
- 기술자료 : 메모, 서신, 영상 및 음성 기록물, 사진, 설계, 컴퓨터 S/W, 공정(절차)서 및 계약서 등 일체의 자료 및 정보
- KARI Korea Aerospace Research Institute
- EOS Electro-Optical Subsystem
- CEM Camera Electronics Module
- CCU Camera Controller Unit
- COC Certificate of Conformity
- DR Design Review
- ICD Interface Control Drawing 또는 Document
- MRR Manufacturing Readiness Review
- NCR Non Conformance Record
- KIP Key Inspection Point
- MIP Mandatory Inspection Point
- SCD Source Control Drawing
- TBD To Be Determined
- TBR To Be Resolved
- TBC To Be Confirmed
- TRR Test Readiness Review
- PTR Post Test Review
- S/C Bus Spacecraft Bus
- RCT Reaction Control Thruster
- EDC Effective Date of Contract for RCT K10 development
- ECO Engineering Change Order
- KO RCT K10 Kick Off Meeting
- SRR RCT K10 System Requirement Review
- SDR RCT K10 System Design Review
- PDR RCT K10 Preliminary Design Review
- CDR RCT K10 Critical Design Review
- MRR RCT K10 Manufacturing Readiness Review
- PTR RCT K10 Post-Test Review

제 2 장. 과제계획서 제출 요령

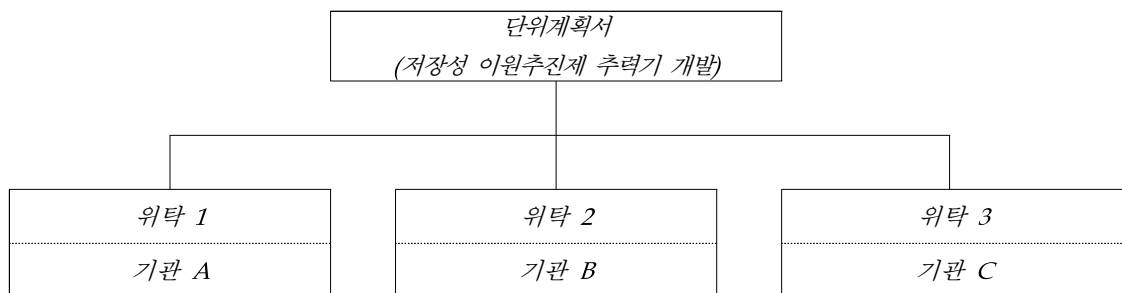
제 1 절. 작성 과제계획서 양식 안내

붙임의 ‘2021년 국책연구본부 신규 계획서 양식’에 작성하되, 참여기업은 사업의 추진 구조에 따라 각각 총괄, 세부, 위탁, 단위 과제계획서를 제출하여야 한다.

<참고> 컨소시엄 구성 시



<참고> 단독 기업/기관 제안 시



제 2 절. 과제계획서 작성 목차

과제계획서는 2021년 국책연구본부 신규 계획서 양식을 기준으로 하여 아래에서 명시한 각각의 세부 항목은 모두 포함하여야 한다.

1. 연구개발과제의 필요성
2. 연구개발과제의 목표 및 평가 기준, 설정 근거
3. 연구개발과제의 내용, 추진체계 및 일정
 - 1) 연구개발과제의 내용
 - 총괄과제 개발 대상 설계 및 세부 개발안 (요구조건에 대한 Compliance Matrix 포함)
 - 검증계획
 - 업무 범위 (RFP 제3장 제3절의 납품목록 포함)
 - 제작, 조립 및 시험 계획
 - 공정 및 품질관리 방안
 - 2) 연구개발과제의 추진체계
 - 사업관리 방안
 - 사업실패 대응계획 (Back-up Plan)
 - 품질인증 체계
 - 우주급 부품 (구성품) 조달계획 (구매관리)
 - 중점관리품목 및 위험요소 관리 방안
 - 자체개발분야 기술의 세부개발안
 - 하청생산 및 위탁 연구 계획 (필요시)
 - 3) 추진 일정 (아래 일정 포함)
 - SRR (System Requirement Review)
 - SDR (System Design Review)
 - PDR (Preliminary Design Review)
 - CDR (Critical Design Review)
 - MRR (Manufacturing Readiness Review)
 - EM PTR(Post-Test Review)
 - QM PTR(Post-Test Review)
4. 연구개발성과의 활용방안 및 기대효과
 - 1) 연구개발성과의 활용방안
 - 2) 연구개발성과의 기대효과
5. 연구수행역량 (연구개발기관 현황 및 역량 포함)
6. 연구개발비 사용에 관한 계획
7. 연구개발 안전 및 보안조치 이행계획
8. 연구개발성과의 사업화 전략 및 계획

제 3 절. 과제계획서 평가 지표 (안)

평가항목	평가 주안점	배점
연구계획 (30)	연구주제안내서(RFP)와의 부합성	10
	연구목표의 명확성 및 달성 가능성(타당성)	10
	연구내용 및 추진체계의 합리성 (컨소시엄 구성 적절성 확인 포함)	10
체계연계성 (30)	체계연계를 위한 중점기술개발 방안 및 구체성	15
	체계연계를 위한 계획의 구체성	15
	◦ 체계연계에 대한 리스크 식별 및 대응방안이 우수한가?	
연구역량 (20)	참여기관 실적의 우수성, 적합성 및 수행능력 평가	10
	참여기관의 재무 건정성 및 신뢰성	5
	참여연구원 구성의 적절성	5
결과활용 (20)	연구결과 활용가능성 및 파급효과	10
	연구결과의 실용성 및 적용방안의 구체성	10
합 계		100

제 4 절. 컨소시엄 또는 기술이전

사업제안기관은 “붙임#4. 한국항공우주연구원 저장성 이원추진제 추력기 보유기술”에 제시한 기술을 고려하여 컨소시엄을 구성하거나 기술이전 형태로 사업추진계획을 제안할 수 있다.

제 3 장. 기술적 요구사항

제 1 절. 요구조건

본 제안 요청서의 붙임#2와 붙임#3의 요구조건에 근거하여 설계, 세부 개발안과 Compliance Matrix와 Verification Matrix를 작성한다.

붙임#2 “저장성 이원추진제 추력기 규격서 (10 N Bipropellant Thruster Equipment Specification)”

붙임#3 “품질인증 요구규격 (Product Assurance Requirements for General Unit)”

제 2 절. 요구사항

가. 성능 요구조건

성능 규격	성능 요구조건*		
추력	$\geq 9.8 \text{ N}$		
비추력	$\geq 287 \text{ s (2815 Ns/kg)}$		
총연소시간	50 hours		
총사이클수	795,000 cycles (700,000 cycles**)		
펄스모드	On-time (ms)	Off-time (ms)	Ibit (mNs)
	5	≥ 2000	≤ 50
	7	≥ 2000	≤ 70

*Equipment Specification 10 N thruster S10-20 with Series Redundant Bipropellant Valve (10N-RILAM-SPE-0006)

**GEO-KOMPSAT-2 Propulsion Subsystem Specification (GK2-SP-460-001)

나. 개발 요구사항

성능 규격	개발 요구사항		
추력	$9.9 \pm 0.2 \text{ N}$		
비추력	$287 \text{ s (2815 Ns/kg)}$		
총연소시간	$\geq 70 \text{ hours}$		
총사이클수	1,000,000 cycles		
펄스모드	On-time (ms)	Off-time (ms)	Ibit (mNs)
	5	≥ 2000	≤ 50
	7	≥ 2000	≤ 70

구분		현재수준	1단계 (1~3차년도)	2단계 (4~6차년도)	3단계 (7~10차년도)	최종
정성목표		이원추진제 추력기 개념설계 및 금속 3D 프린팅 경험 확보	우주급을 고려한 최적의 설계 및 시제품 제작 (EM)	유사한 우주환경 인증시험을 통한 지상검증 수행 (QM)	-	유사한 우주환경 인증시험을 통한 지상검증 수행 (QM)
정량 목표	TRL단계	3	5	7	-	7
	기술수준	40%	-	95%	-	95%

다. 연차별 목표 및 평가지표 (예시)

평가항목	가중치(%)	연차	연차별 목표 (조건/환경)
(정량) 10N급 이원추진제 추력기 설계/해석/제작	30	1차년도	이원추진제 추력기(추력 10 N, 비추력 287 s) 개발 계획서, 설계 보완 및 예비 설계와 해석
		2차년도	이원추진제 추력기(추력 10 N, 비추력 287 s) 상세 설계와 해석
		3차년도	이원추진제 추력기(추력 10 N, 비추력 287 s) EM 제작 및 조립
		4차년도	이원추진제 추력기(추력 10 N, 비추력 287 s) QM 제작 및 조립
		5차년도	이원추진제 추력기(추력 10 N, 비추력 287 s) QM 우주환경 및 인증연소 시험(누적연소 50 시간)
(정성) 내열 항산화 이종금속(희귀 합금) 연소실/노즐 개발	30	1차년도	절삭가공과 적층제조(금속 3D 프린팅) 복합공정 기술 분석 및 초기공정 개발
		2차년도	절삭가공과 적층제조(금속 3D 프린팅) 복합공정 공정 최적화 및 시험
		3차년도	절삭가공과 적층제조(금속 3D 프린팅) 복합공정 최적화 및 시험 (계속)
		4차년도	절삭가공과 적층제조(금속 3D 프린팅) 복합공정 표준화
		5차년도	절삭가공과 적층제조(금속 3D 프린팅) 복합공정 표준화(계속)
(정량) 10N급 이원추진제 추력기 검증 연소시험	40	1차년도	이원추진제 추력기 제작/조립 및 연소시험장 구축 또는 보완 계획 수립 및 착수 (연소실 진공수준 0.5 mbar 시작, 5 mbar 유지)
		2차년도	이원추진제 추력기 제작/조립 및 연소시험장 구축 또는 보완 계획 수행 (연소실 진공수준 0.5 mbar 시작, 5 mbar 유지)
		3차년도	이원추진제 추력기 EM 연소시험 및 개선 (연소실 진공수준 0.5 mbar 시작, 5 mbar 유지)
		4차년도	이원추진제 추력기 QM 예비시험 및 개선 (연소실 진공수준 0.5 mbar 시작, 5 mbar 유지)
		5차년도	이원추진제 추력기 제작/조립/연소시험장 운용 (연소실 진공수준 0.5 mbar 시작, 5 mbar 유지)

○ 평가항목의 설정 근거

평가항목	목표 설정근거
(정량) 10N급 이원추진제 추력기 설계/해석/제작	저장성 이원추진제 추력기의 유사연구 개발 수준은 ArianeGroup (독일) 추력 10 N, 비추력 292 s, Moog (미국) 추력 9 N, 비추력 274 s이며 본 과제의 세부목표는 체계사업의 요구사항에 부합하도록 절삭가공과 적층제조(금속 3D 프린팅) 복합공정 공정을 적용하여 추력 10 N, 비추력 287 s 이상으로서 설정함. 참고: ArianeGroup (독일) 10 N Bi-Propellant Thruster의 Qualified accumulated burn life: 70 hours; Qualified cycle life: 1,000,000 cycles 임.
(정성) 내열 항산화 이중금속 (희귀합금) 연소실/노즐 개발	내열 항산화성이 검증된 백금/로듐 합금 및 백금/이리듐 합금을 사용하는 절삭가공과 적층제조(금속 3D 프린팅) 복합공정을 개발하여 연소실/노즐에 적용하는 도전적이지만 충분히 개발 가능한 기술임.
(정량) 제작/조립 및 연소시험장 보완(산화제 부분 추가 등) 계획 수립 및 착수 (연소실 진공수준 0.5 mbar 시작, 5 mbar 유지)	본 저장성 이원추진제 추력기의 유사 연소시험장인 ArianeGroup (독일)의 연소시험장의 연소실 진공수준은 0.5 mbar 시작, 5 mbar 유지임. 본 세부 과제의 연소시험장 연소실 진공수준을 동등하게 설정함.

라. 시험검증방안

- 저장성 이원추진제 추력기 개발을 위한 시험계획을 수립하고 각각의 부품시험절차서에 따라 검증 시험을 수행함
- 우주환경시험은 국내 시설 및 시험인력을 이용하여 진행할 예정임

제 3 절. 납품항목 목록

가. 납품 문서 목록

Program Management		
SPP-K10-PLN-001	Configuration and Data Management Plan	EDC+1M
SPP-K10-RPT-001	Monthly Progress Report	EDC+every month
Program Assurance		
SPP-K10-PLN-002	10 N Bipropellant Thruster Qualification Plan	P-SDR, R-As revised, F-CDR
SPP-K10-DVM-001	RCT K10 Compliance and Verification Matrix	EDC+1M
SPP-K10-SOC-001	Statement of Compliance to “Subcontractor Product Assurance Requirements”	EDC+1M
SPP-K10-CH-001	Manufacturing / Inspection Flow Chart	P-PDR, R-As revised, F-CDR
SPP-K10-TN-006	Reliability Report	P-PDR, R-As revised, F-CDR
SPP-K10-LIS-001	10 N Bipropellant Thruster Parts, Materials and Process List	P-PDR, R-As revised, F-CDR
SPP-K10-TN-002	FMECA	P-PDR, R-As revised, F-CDR
SPP-K10-LIS-002	Critical Item List	P-SDR, R-As revised, F-CDR
SPP-K10-HP-001	User’ s Handling Manual	F-PSR
System Engineering		
SPP-SP-460-010	10 N Bipropellant Thruster Equipment Specification	
SPP-K10-TN-001	RCT K10 Design Description	P-SDR, R-As revised, F-CDR
SPP-K10-SRR-001	SRR (Syste Requirement Review)	EDC + 1 months
SPP-K10-SDR-001	SDR (System Design Review)	EDC + 3 months
SPP-K10-PDR-001	PDR (Preliminary Design Review)	EDC + 8 months
SPP-K10-CDR-001	CDR (Critical Design Review)	EDC + 20 months
SPP-K10-MRR-001	MRR (Manufacturing Readiness Review)	EDC + 32 months
SPP-K10-PTR-001	EM PTR (Post-Test Review)	EDC + 44 months
SPP-K10-PTR-002	QM PTR (Post-Test Review)	EDC + 56 months
SPP-K10-TN-003	Performance Analysis Report	P-PDR, R-As revised, F-CDR
SPP-K10-TN-004	Structure Analysis Report	P-PDR, R-As revised, F-CDR
SPP-K10-TN-005	Thermal Analysis Report	P-PDR, R-As revised, F-CDR
SPP-K10-ICD-001	10 N Bipropellant Thruster Interface Control Drawing	P-PDR, R-As revised, F-CDR
SPP-K10-AD-001	RCT K10 Drawing Tree	P-PDR, R-As revised, F-CDR
SPP-K10-AD-002	3D CAD model (STEP file format)	P-PDR, R-As revised, F-CDR
SPP-K10-RPT-002	10 N Bipropellant Thruster Qualification Test Report	2 weeks after ATP

Program Management		
SPP-K10-PLN-001	Configuration and Data Management Plan	EDC+1M
SPP-K10-RPT-001	Monthly Progress Report	EDC+every month
Program Assurance		
SPP-K10-PLN-002	10 N Bipropellant Thruster Qualification Plan	P-SDR, R-As revised, F-CDR
SPP-K10-DVM-001	RCT K10 Compliance and Verification Matrix	EDC+1M
SPP-K10-SOC-001	Statement of Compliance to “Subcontractor	EDC+1M

	Product Assurance Requirements”	
SPP-K10-CH-001	Manufacturing / Inspection Flow Chart	P-PDR, R-As revised, F-CDR
SPP-K10-TN-006	Reliability Report	P-PDR, R-As revised, F-CDR
SPP-K10-LIS-001	10 N Bipropellant Thruster Parts, Materials and Process List	P-PDR, R-As revised, F-CDR
SPP-K10-TN-002	FMECA	P-PDR, R-As revised, F-CDR
SPP-K10-LIS-002	Critical Item List	P-SDR, R-As revised, F-CDR
SPP-K10-HP-001	User’ s Handling Manual	F-PSR
System Engineering		
SPP-SP-460-010	10 N Bipropellant Thruster Equipment Specification	
SPP-K10-TN-001	RCT K10 Design Description	P-SDR, R-As revised, F-CDR
SPP-K10-SRR-001	SRR (Syste Requirement Review)	EDC + 1 months
SPP-K10-SDR-001	SDR (System Design Review)	EDC + 3 months
SPP-K10-PDR-001	. PDR (Preliminary Design Review)	EDC + 8 months
SPP-K10-CDR-001	. CDR (Critical Design Review)	EDC + 20 months
SPP-K10-MRR-001	. MRR (Manufacturing Readiness Review)	EDC + 32 months
SPP-K10-PTR-001	. EM PTR (Post-Test Review)	EDC + 44 months
SPP-K10-PTR-002	. QM PTR (Post-Test Review)	EDC + 56 months
SPP-K10-TN-003	Performance Analysis Report	P-PDR, R-As revised, F-CDR
SPP-K10-TN-004	Structure Analysis Report	P-PDR, R-As revised, F-CDR
SPP-K10-TN-005	Thermal Analysis Report	P-PDR, R-As revised, F-CDR
SPP-K10-ICD-001	10 N Bipropellant Thruster Interface Control Drawing	P-PDR, R-As revised, F-CDR
SPP-K10-AD-001	RCT K10 Drawing Tree	P-PDR, R-As revised, F-CDR
SPP-K10-AD-002	3D CAD model (STEP file format)	P-PDR, R-As revised, F-CDR
SPP-K10-RPT-002	10 N Bipropellant Thruster Qualification Test Report	2 weeks after ATP

※ 상기 납품문서는 사업단과 세부과제 주관기관의 협의하에 조정될 수 있음.

또한, 작성 및 관리방법에 대해서는 사업단에서 지원/협력할 수 있음.

나. 하드웨어 개발 목록 (일정은 제안시 변경제안 가능)

No	Item	Quantity	Delivery Date	Notes
1	EM	1 set	EDC + 32 months	
2	QM	1 set	EDC + 56 months	

제 4 절. 진도점검회의

아래의 주요 진도점검회의는 본 사업 연구개발성과의 체계연계를 위해 필수적으로 판단되는 사항이며, 아래 진도점검회의 외에도 스페이스파이오니어사업단 및 관련 부처, 연구재단 및 연구개발수행기관의 요구발생시 수시로 설계 및 개발경과 관련 회의가 개최되어야 한다.

동시에 연구개발수행기관은 매달 사업단에 연구개발진도 보고서를 제출한다.

□ 주요일정

- SRR (System Requirement Review)
- SDR (System Design Review)
- PDR (Preliminary Design Review)
- CDR (Critical Design Review)
- MRR (Manufacturing Readiness Review)
- EM PTR (Post-test Readiness Review)
- QM PTR (Post-test Readiness Review)

표 4 사업 주요일정 (사업 제안시 변경제안 가능)

사업기간	사업일정	예정일 (TBD)	비고
2021.5.1. ~ 2025.12.31	EDC	TBD	
	SRR	EDC + 1 months	
	SDR	EDC + 3 months	
	PDR	EDC + 8 months	
	CDR	EDC + 20 months	
	MRR	EDC + 32 months	
	EM PTR	EDC + 44 months	
	QM PTR	EDC + 56 months	

※ EDC : Effective Date of Contract, 협약일

제 4 장. 기타 특수조건

본 제안요청서의 붙임#2와 붙임#3와 본 장에서 언급하는 것에 상충하는 것이 있다면 본 장의 내용이 우선한다.

제 1 절. 연구개발수행기관의 책임 및 의무사항

연구개발수행기관은 주요 제작 공정 및 품목을 사진(연도/월/일 포함) 혹은 동영상으로 기록하여 유지한다.

제 2 절. 개발품목 시험

- 연구개발수행기관은 본 사업의 과제제안요청서에 언급된 “개발” 품목의 검증시험을 도면에 명기하여 수행해야 한다.
- 단, 검증시험 방법에 이견이 있을 시, 개발수행기관이 제시하는 방법이 당초 제안요청서에서 요구하는 방법과 차이가 없음을 입증해야 한다.
- 연구개발수행기관은 수용 가능한 경우 사업단에서 요구하는 검증시험을 추가 비용 없이 수행하고, 수행 후 2주일 내에 시험 결과를 사업단에 제출해야 한다. 요구성능 미달 시, 이에 대한 기술회의를 사업단과 수행한 후 제시된 개선책에 따라 재시험을 수행해야 한다.
- 모든 검증시험 경우, 계획서는 사전에 사업단의 승인을 득해야한다. 연구개발수행기관의 시험 항목 및 방법 변경 시는 사업단과 서면 협의 후 새로운 방법에 대한 검증이 선행되어야 한다.
- 이러한 검증시험은 연구개발수행기관에 의해 수행되거나 “연구개발수행기관과 계약을 맺은 전문 시험기관에 의하여 수행될 수 있으며, 이 경우 사업단이 지정한 검사원이 입회할 수 있다.
- 본 제안요청서에서 요구하는 계획 이외의 환경시험은 협의하여 수행한다.

제 3 절. 제품보증

- 연구개발 수행기관은 사업단의 제품보증 요구조건(Products Assurance Requirements, 이하 “PAR”) 및 사업단의 승인을 받은 연구개발수행기관의 제품보증계획서(Product Assurance Program Plan, 이하 “PAPP”)를 준수하여 “개발” 된 납품품목을 납품해야 한다.
- 연구개발수행기관은 “PAR” 및 “PAPP”에 따라 제품보증 활동을 수행해야

하며, 이에 적합한 조직과 인력을 구성해야 한다.

- 사업단은 연구개발수행기관 혹은 연구개발수행기관의 외주업체에 대한 제품 보증 활동을 주기적으로 확인 및 감독 할 수 있으며, 필요시 시정 조치를 요구할 수 있다.
- 사업단이 연구개발수행기관 혹은 연구개발수행기관의 외주업체에 대한 품질확인(MIP: Mandatory Inspection Point 포함)을 실시하는 경우, 연구개발 수행기관은 사업단이 요구하는 모든 필요한 지원을 제공해야 하며, 품질확인에 대한 승인을 득해야 한다.
- 연구개발수행기관은 “PAPP”에 따른 전 과정 및 납품품목의 품질에 대한 최종 책임을 진다.

제 4 절. 진도관리

- 연구개발수행기관은 계약 완료일까지 개발에 대한 진도보고서(일정계획 포함)를 매월 사업단에게 제출해야 한다.
- 연구개발수행기관은 위 제3장 제4절 진도점검 회의 일정에 따라 진도점검 회의를 개최해야 한다.
- 연구개발수행기관은 사업단의 요구에 따라 주간, 격주 혹은 월간 단위로 “개발” 회의를 진행하고 사업단의 요구에 따라 관련 자료를 제출해야 한다.
- 사업단은 필요하다고 판단되는 시기에 연구개발수행기관에 대한 실사를 실시할 수 있으며, 실사결과에 따라 필요시에는 연차평가 및 차년도 협약에 반영한다.

제 5 절. 도면관리

- “연구개발수행기관은 “개발”에 관련된 모든 도면이 제작 시작 전 사업단의 서면 승인이 완료되도록 지원해야 한다.
- 연구개발수행기관에 의하여 생성되는 도면은 사업단에 의한 “도면작성방법”, “도면 작성 및 배포 절차” 및 “도면번호” 등을 따르며, 사업단의 형상 관리 절차에 따라 사업단의 CDMO(Configuration Data Management Office)에 등록한다.
- 또한, 연구개발수행기관은 “PAPP”에 따른 자체 도면관리 체계를 갖추어야 한다.

제 6 절. 사업단(체계연계지원팀 등)의 기술 관리 수용

- 사업단(체계연계지원팀 등)의 세부 개발 사양 검토 및 요건이 반영되도록 하여야 한다.
- 사업단(체계연계지원팀 등)이 지정한 연구진 출입 및 관련 자료, 연구성과물 등에의 열람을 보장하고, 기술 관리가 수행될 수 있도록 지원하여야 함
 - ※ 연구개발계획서 내 기술관리를 수용할 수 있는 추진 계획을 제시하여야 함
- 최종 연구성과물의 활용도 제고를 위하여, 후속 체계사업과 관련된 제반사항(시험 등) 지원 등을 성실히 수행하여야 함

제 7 절. 해외 수출면허 규정

본 사업의 개발품은 해외 수출면허 규정의 제한을 받지 않도록 개발하여야 함.
개발 특성상 해외수출면허 부품사용이 불가피할 경우 이후 개발을 위한 대안이나 대비계획을 제시하여야 함

제 8 절. 불입

불입은 본 제안요청서의 일부로 본다.

붙임#1. 보안유지 서약서

보안유지 서약서

관 련 : 2021년도 스페이스파이오니어사업 세부과제 선정 관련
기술문서 습득

과 제 명 :

수령자 및 수령기관(이하 수령인)은 2021 스페이스파이오니어사업의 세부과제 선정과 관련된 제안요청서에 부속한 기술문서를 수령함에 있어, 본 기술문서들이 보안 및 재산적 정보로 간주됨을 인정하고 동의합니다. 본 기술문서의 수령 목적은 오로지 2021 스페이스파이오니어사업의 세부과제에 선정되기 위함이며, 수령인은 본 기술문서 상의 정보 및 검토과정에서 습득한 모든 정보와 지식을 자신의 재산적 정보를 보호하는 관리수준과 동일한 정도로 타인에게 누설되지 않도록 보호하여야 함을 인정하고 동의합니다. 수령인은 스페이스파이오니어사업단(이하 사업단)의 사전 서면 승인 없이 기술문서를 상기 관련에서 규정한 목적이외에는 사용할 수 없음을 인정하고 동의합니다. 본 기술문서 뿐 아니라 이에 기반하여 복사 또는 복제로 창출된 모든 기술적 정보는 사업단의 소유이며 세부과제 선정 과정 이후, 사업단의 서면 요청 시점으로부터 30일 이내에 수령인의 선택에 의하여 즉각 사업단에 반환되거나 파기되어야 하며, 파기의 경우 수령인은 상기 서면 요청일로부터 30일 이내에 동 요청을 이행하였다는 서면 확인서를 사업단에 제공하여야 함에 동의합니다.

2021년 4월 일

수령기관 : _____ (인)

수령자 : _____ (인)

붙임#2. 저장성 이원추진제 추력기 규격서 (10 N Bipropellant Thruster Equipment Specification)

- 10 N Bipropellant Thruster Equipment Specification, SPP-SP-460-010 참조
- * 상세기술자료는 스페이스파이오니어사업단(한국항공우주연구원 내)에 방문, 보안서약서(붙임#1 참조) 오프라인 제출 이후 직접 수령 가능

붙임#3. 품질인증 요구규격 (General Unit Product Assurance Requirements)

- 별도문서



Space Pioneer Program
**Product Assurance Requirements
for General Unit**

Date: 15 April 2021

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1. INTRODUCTION

1.1. GENERAL

1.1.1. 과제에서 합의된 요구사항에 대한 적합성 입증(Compliance Demonstration to Consensus Requirements)

- 스페이스파이오니아사업에 참여하는 장비/유닛의 개발시 요구사항(Requirements)은 RFP문서에서 정하는 기본 요구사항(General Requirements)이다.
- 세부과제 주관기관은 기본 요구사항에 추가하여 목표로 하는 실용위성 또는 목표시장에서 포지셔닝 하고자 하는 기대목표를 충족하기 위하여 추가적으로 필요한 요구사항(Voluntary Consensus Standards/Specifications)을 제안하여야 한다.
- 세부과제 주관기관은 과제에서 정한 기본요구사항과 합의된 추가하고자 입증하고자 하는 요구사항(Consensus Standards/Specifications)에 적합함을 입증(Demonstration of Compliance to Requirements)하여야 한다.

1.1.2. 사업단 참여 보장(Access Right)

- 스페이스파이오니아 사업의 목적을 위해 필요한 활동을 이행할 수 있도록 사업단 또는 사업단이 지정한 대리인이 세부과제 주관기관의 시설(협력업체 및 참여기관을 포함한다.) 및 문서에 접근(제공을 포함한다.)할 수 있도록 협조하여야 한다. 지적재산과 관련한 내용을 포함하는 경우, 비밀유지합의서(Non-disclosure agreement)와 같은 제도적 장치를 통해 문서 및 시설에 대한 접근을 보장할 수 있는 적극적인 방안을 고려하여야 한다.

1.1.3. 사실 기반 확인(Evidence based Verification)

- 세부과제 주관기관은 적합성에 대한 입증이 사실(설계, 해석, 시험, 검사, 도면, 절차서/표준서, 운용 매뉴얼/절차 등의 객관적인 증거)에 기반한 적합성 확인이 되도록 하여야 한다.

1.1.4. 적합성점검표(Compliance Summary Table)

- 세부과제 주관기관은 본 문서에 대한 적합성 입증계획 및 입증결과를 요약한 적합성점검표 (Compliance Summary Table)를 과제 착수시점에 작성하여 과제기간 동안 입증결과를 요약한 내용을 업데이트하여 재개정 관리를 이행하여야 하며, 과제종료시점에 최종본을 제출하여야 한다.

1.1.5. 프로그램 기술관리 검토회의 (Program Review)

- 세부과제 주관기관은 다음의 개발품에 대한 검토회의(Design Reviews and/or EQSR, MRR, TRR/PTR, PSR) 수행체계를 갖추어야 한다. 수행체계는 INPUT(작성문건, 발표자료 템플릿)과 OUTPUT(회의록, Action Item, Data Package)의 관리를 포함하여야 한다.
- 세부과제 주관기관은 검토회의와 관련하여 APPENDIX D를 참조한다.
- 기술관리 검토회의의 Go/No-Go Decision 권한은 사업단에게 있다.

1.2. 약어 및 정의 (ACRONYMS AND DEFINITIONS)

ABCL	As Built Configuration List
ACA	At Contract Award
AIT	Assembly, Integration, and Test
ASIC	Application Specific Integrated Circuit
ASTM	American Society for Testing and Materials
CADM	Configuration And Data Management
CCB	Configuration Control Board
CDR	Critical Design Review
CDRL	Contractual Document Requirements List
CFE	Customer Furnished Equipment
CI	Configuration Item
CIDL	Configuration Item Document List
CIL	Critical Items List
COC	Certificate of Conformance
CPPA	Centralized Part Procurement Agency
CVCM	Collected Volatile Condensable Mass
DDEF	Displacement Damage Equivalent Fluence
DDSF	Displacement Damage Sensitive Fluence
DPA	Destructive Physical Analysis
ESCC	European Space Component Coordination
EEE	Electrical Electronic, and Electromechanical
EGSE	Electrical Ground Support Equipment
EIDP	End Item Data Package
EM	Engineering Model
EMC	Electromagnetic Compatibility

EOL	End of Life
EPPL	European Preferred Part List
ESA	European Space Agency
ESD	Electrostatic Discharge
ESR	Equipment Suitability Review
FDIR	Fault Detection, Isolation, and Recovery
FM	Flight Model
FMECA	Failure Modes, Effects, and Criticality Analysis
FTA	Fault Tree Analysis
GIDEP	Government Industry Data Exchange Program
GSFC	Goddard Space Flight Center
IC	Integrated Circuit
ICD	Interface Control Document
IOC	Interoffice Correspondence
KIP	Key Inspection Point
LAT	Lot Acceptance Test
LET	Linear Energy Transfer
M&P	Materials and Processes
MGSE	Mechanical Ground Support Equipment
MIL-STD	Military Standard
MIP	Mandatory Inspection Point
MMIC	Microwave Monolithic Integrated Circuits
MPCB	Material and Process Control Board
MRB	Material Review Board
MRR	Manufacturing Readiness Review
MUA	Material Usage Agreement
NASA	National Aeronautics and Space Administration
NCR	Non-Conformance Report
NDT	Non-Destructive Testing
NPSL	NASA Parts Selection List
NSPL	MIL-STD-975, NASA Standard Electrical, Electronics, and Electromechanical Parts List
NVR	Nonvolatile Residue
PA	Product Assurance
PAD	Part Approval Document

PAPP	Product Assurance Program Plan
PAR	Product Assurance Requirements
PCB	Part Control Board
PDR	Preliminary Design Review
PEM	Plastic Encapsulated Microcircuit
PIL	Part Identification List
PIND	Particle Impact Noise Detection
PM&P	Parts, Materials and Processes
PMPCB	Parts, Materials, and Processes Control Board
PPL	Preferred Part List
PPM	Part Per Million
PSA	Part Stress Analysis
PSR	Pre-Ship Review
QA	Quality Assurance
QCI	Quality Conformance Inspection
QPL	Qualified Part List
RF	Radio Frequency
RFA	Request for Approval
RFD	Request for Deviation
RFW	Request for Waiver
SEB	Single Event Burn Out
SEFI	Single Event Functional Interrupt
SEGR	Single Event Gate Rupture
SEL	Single Event Latch Up
SEP	Single Event Phenomenon
SES	Single Event Snap Back
SET	Single Event Transient
SEU	Single Event Upset
SOW	Statement of Work
TCI	Technology Conformance Inspection
TID	Total Ionizing Dose
TML	Total Mass Loss
TRR	Test Readiness Review
TQCM	Thermal Electrically Controlled Quartz Crystal Microbalance
UV	Ultraviolet Ray

WCA Worst Case Analysis

2. APPLICABLE DOCUMENTS

Applicable documents and revision levels listed herein form a part of this document.

If any conflict arises between this PAR and those referenced, the requirements of this PAR shall take precedence and govern until resolved by KARI.

2.1. US MILITARY AND NASA DOCUMENTS

MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-889 A	Dissimilar Metals
MIL-STD-975 M	NASA Standard Electrical, Electronics, and Electromechanical Parts List
MIL-STD-981C	Design, Manufacturing and Quality Standards for Custom Electromagnetic Devices for Space Applications
MIL-STD-1547 B	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-HDBK-217 F Notice 2	Reliability Prediction of Electronic Equipment
MIL-PRF-38534G	Hybrid Microcircuits, General Specification for
GSFC EEE-INST-002	Instructions for EEE Part Selection, Screening, Qualification, and Derating
NASA-STD-(I)-6001A	Flammability, Off-gassing, and Compatibility Requirements and Test Procedures

2.2. ESA DOCUMENTS

ECSS-E-30 Part 6A	Mechanical - Part 6: Pyrotechnics
ECSS-Q-ST-30-11C	Derating - EEE Components
ECSS-Q-60-11A	Derating and End-of-life Parameter Drifts - EEE Components
ECSS-Q-ST-60-02C	ASIC and FPGA Development
ECSS-Q-ST-60-12C	Design, Selection, Procurement and Use of Die-form Monolithic Microwave Integrated Circuits
ECSS-Q-ST-60-14C	Reliefing Procedure - EEE Components
ECSS-Q-70B	Materials, Mechanical Parts and Processes
PSS-01-608	Generic Specification for Hybrid Microcircuits
ECSS-Q-70-36A	Material Selection for Controlling Stress-corrosion Cracking

3. 제품보증 관리(PRODUCT ASSURANCE MANAGEMENT)

3.1. 제품보증 계획(PA PROGRAM PLANNING)

3.1.1. 제품보증 조직/책임(PA Organization and Responsibilities)

- 스페이스파이오니아사업에 참여하는 위성용 장비 개발기관(이하 "세부과제 주관기관"이라 한다.)은 책임과 권한을 갖는 제품보증 책임자(이하 "PA책임자"라 한다.)와 PA 엔지니어링(신뢰성, 안전성, 신뢰성, 재부품공정, 소프트웨어 보증) 담당자 및 PA 품질/관리(품질관리, 오염관리, 구매관리, 안전관리) 관련 담당자를 지정하여야 한다.

[주기] 우주제품은 우주사용중 수리가 어려운 1회 개발/제작/사용의 특징을 갖는 제품군이므로 개발/검증 단계에서부터 PA 책임자 및 전문 PA 인력의 참여가 필수적으로 요구된다.

[주기] 별도의 PA책임자를 지정하지 않는 경우, 세부과제 주관기관 과제책임자(PM)가 PA 책임자의 기능을 겸하는 것으로 간주하여야 한다.

[주기] "전기전자부품 관리", "소프트웨어 보증"에 한해, 제품 개발 범위에 포함되지 않는 경우 해당 담당자를 두지 않아도 된다. 이 외의 모든 PA 분야에 대해서는 담당자를 지정하여야 한다.

- PA책임자는 PA 업무를 이행함에 있어서 PA 엔지니어링 담당자와 품질/관리 관련 담당자의 업무를 관리하여야 한다.

3.1.2. PA책임자의 협업(PA Management Interfaces)

- 세부과제 주관기관은 PA책임자가 다음의 업무를 이행하도록 하여야 한다.

- 1) PA책임자는 PA 관련 이슈와 관련하여 세부과제 주관기관 과제책임자와 협력하여야 한다.
- 2) PA책임자는 세부과제 주관기관내 형상관리, 위험관리, 체계종합, 엔지니어링 개발 부서와 PA 관련 이슈와 관련하여 협력하여야 한다.
- 3) PA책임자는 참여업체 및 Lower-Tier업체와의 PA 관련 이슈를 관리하여야 한다.
- 4) PA책임자는 과제의 기술검토회의(Design Review/EQSR, MRR, TRR, PTR, PSR)에 참여하여 PA 관련 이슈, PA 문서, PA 활동현황 등 PA 관련 내용을 제시하여야 한다.

3.1.3. 제품보증 이행계획서(PA Plan)

- 세부과제 주관기관은 스페이스파이오니아 사업에서 정한 본 문서에 따른 장비 제품보증요구사항(PA Requirements for General Unit)을 만족하는 제품보증 계획서를 스페이스파이오니아 사업단에 작성하여 제출하고 이행하여야 한다. 제품보증 이행계획서(PAP, PA Plan)의 문서 구성은 **APPENDIX A**를 참조한다.

[주기] 세부과제 주관기관은 향후 실용위성개발에 참여시에 고객이 발행하는 제품보증요구사항(Subcontractor PA Requirements)을 만족하는 제품보증계획서를 작성하여 제출하여야 하며, PA책임자는 고객의 Subcontractor PAR 요구사항에 따라 PA 관련 이슈에 대응하여야 한다. 세부과제 주관기관은 Subcontractor PAR과 본 PAR for General Unit의 목적과 다루는 범위가 차이가 있을 수 있음을 명확하게 인지하고 적절한 대책을 수립하여 시행하여야 한다.

3.2. 제품보증계획 이행(PA PLAN IMPLEMENTATION)

3.2.1. PA 관리(PA management)

- 세부과제 주관기관은 설계 초기 단계부터 제품보증 요건에 대한 적합성을 고려한 설계를 수행하여 PA 관련 이슈를 식별하고 관리하여야 한다.
- 세부과제 주관기관은 PA 이행계획을 구현하는 데 필요한 PA 자원을 식별하고 PA 작업을 이행할 수 있는 자원을 제시하여야 한다.
- 세부과제 주관기관은 참여업체 및 Lower-Tier 협력업체가 본 문서 및 PA 이행계획에 따라 관리됨을 보증하여야 한다.

3.2.2. PA 진행현황보고(PA Status Reporting)

- 세부과제 주관기관은 PA책임자가 개발일정별로 요구되는 제품보증문서 현황 및 개발중 발생하는 모든 PA 관련 이슈를 관리하여야 한다.
- PA책임자는 최소한 다음 사항을 포함한 PA 현황보고서(PA Status Report)를 작성하여 진행현황을 사업관리의 일부로 보고하여야 한다. PA 현황보고서는 정기적으로 보고되는 과제현황보고서의 일부로 통합하여 관리할 수 있다. PA Status Report에 포함되어야 할 내용은 **APPENDIX B**를 참조한다.

3.2.3. 중요관리대상 관리(Critical Items control)

- 세부과제 주관기관은 중요관리대상(Critical Item)을 식별하고 식별된 중요관리대상의 리스크를 제거(removal)하거나 완화(mitigation) 또는 원하지 않는 결과를 예방하기 위하여 취해야 하는 방안을 포함하는 조치계획(action plan)을 수립하고 관리하여야 한다.
- 중요관리대상 관리와 관련하여 **APPENDIX H**를 참조한다.

3.2.4. 문서 작성 및 자료 관리(Documentation and Data control)

- PA 책임자는 PA 이행계획 실행에 필요한 활동이 진행되는 모든 장소에서 유효한 문서 및 데이터가 사용될 수 있도록 하여야 한다. 유효하지 않은 문서 및 데이터는 사용시점에 사용장소에서 제거되도록 하여 의도하지 않은 사용을 방지하여야 한다.
- PA 책임자는 PA 승인이 필요한 문서를 포함하여 승인이 필요한 과제문서를 식별하여야 한다.

3.2.5. 품질기록(Quality Records)

- 세부과제 주관기관은 모든 PA 작업의 완전하고 성공적인 이행을 위한 객관적인 증거를 제공하고 요구 사항 준수를 입증하기 위해 품질 기록 관리체계를 수립하고 유지해야 합니다.

3.2.6. 형상관리 관련 PA 역할(PA contribution to configuration management)

- PA 책임자는 형상관리활동의 일부로 참여하여 도면, 시험 계획/절차서, 규격서/절차서 (해당문서의 변경사항을 포함한다.)의 사용을 위한 배포(Release)가 적합한 지를 확인해야 한다.
- PA 책임자는 설계형상(As-designed configuration status)이 문서로 모두 식별되었는지와 제작 착수전에 배포되는 지를 확인하여야 하며, 제작형상(As-built configuration status)이 문서로 모두 문서로 식별 및 기록되어 제품과 함께 최종산출물(EIDP)의 일부로서 제공되도록 하여야 한다.

3.2.7. 부적합관리(Nonconformance control)

- 세부과제 주관기관은 고객(향후 실용위성 개발기관 또는 차상위 서브시스템/장비유닛 개발기관)에게 주의 및 판단이 필요한 정보를 제공할 수 있도록, 개발중 발생한 모든 제작/시험/시험운용 중 발생하는 부적합과 이에 대한 처리내용 및 예방조치를 포함하는 정보를 제공할 수 있는 체계를 수립하여 운용하여야 한다.
- 부적합기록(Nonconformance Record) 체계, 부적합검토위원회(MRB) 구성, 부적합검토위원회(MRB) 회의록 체계 등을 포함하여야 한다.
- 세부과제 주관기관은 부적합관리 계획 수립시 **APPENDIX E**을 참조한다.
- 개발단계에서 부적합은 인정되지 않는 것이 일반적이다. 따라서 세부과제 주관기관은 **Major** 부적합은 설계 변경을 통해 제품의 특성으로 반영하는 것을 원칙으로 하여야 한다.

[주기] 세부과제 주관기관은 개발단계에서 고객(Satellite System Integrator) MRB에 의한 피드백을 받을 수 없음을 인지하여야 하며, 향후 이러한 MRB에 대응하는 체계를 갖추어야 한다. 세부과제 주관기관에서 수용한 NCR은 향후 고객(Satellite System Integrator)에게 보고되어야 하며, 최종 판단권한은 고객에게 있음을 인지하여야 한다.

3.3. CONFIGURATION CONTROL (형상관리)

- 세부과제 주관기관은 형상관리계획 수립시 **APPENDIX F**를 참조한다.
- 개발단계에서 규격에 대한 RFD/RFW를 통한 면제 처리는 인정되지 않는 것이 일반적이다. 따라서 세부과제 주관기관은 RFD/RFW로 예상되는 규격 불일치는 설계 변경을 통해 제품의 특성으로 반영하거나, 재제작/재시험 등을 통해 규격을 만족함을 보여야 한다.

[주기] 세부과제 주관기관은 개발단계에서 고객(Satellite System Integrator) CCB에 의한 피드백을 받을 수 없음을 인지하여야 하며, 향후 이러한 CCB에 대응하는 체계를 갖추어야 한다.

4. PA 기능별 요건(PA REQUIREMENTS PER DISCIPLINES)

4.1. QUALITY ASSURANCE (품질보증)

- 세부과제 주관기관은 **APPENDIX G**를 만족하는 제품보증 관리 계획을 수립하여 이행하여야 한다.
- 세부과제 주관기관은 세부과제 주관기관 내에 제품개발에 적합한 품질보증 체계를 수립하여 이행할 책임이 있다.

[주기] ISO9001, AS9100, TS16949와 같은 품질경영시스템 인증이 별도로 개발하고자 하는 우주개발품의 업무범위를 포함하고 있지 않는 한, 우주개발에 적합한 품질경영시

시스템을 갖추고 있음으로 해석되지 않아야 한다. AS9100 항공우주 품질경영시스템의 목적에서 선언하고 있는 바와 같이, 고객 및 제도적 요건을 반영한 품질경영시스템을 구축하여 운용하기 위해 노력해야 한다.

- 세부과제 주관기관은 구매품(하드웨어, 소프트웨어 및 서비스)의 구매관리 체계 수립 시, 추적성 확보를 위해 사용 자재의 원재작자 보증서(Original Manufacturer's COC)가 확보될 수 있도록 구매요구사항의 일부로 기술하고 인수검사시 이를 확인하여야 한다.
- 세부과제 주관기관은 개발단계에서 고객(Satellite System Integrator)에 의한 고객검사(MIP, Mandatory Inspection Point)의 지정 및 실행에 의한 피드백을 받을 수 없음을 인지하여야 하며, 고객검사 수준의 기능적으로 독립적인 인력에 의한 전문적인 자주검사(KIP, Key Inspection Points)가 수행될 수 있도록 검사체계를 구축하여야 한다.
- KIP/MIP 검사를 상정하는 경우 다음을 고려하여야 한다.
 - 1) 중요공정(critical process)이 수행된 후 실시
 - 2) 후속공정에서 검사를 위한 접근이 불가능한 경우 후속공정전 실시
 - 3) 메카니즘의 조립 기간동안 실시
 - 4) Safety Critical Item의 장착 과정동안 실시
 - 5) Qualification Test 및 Acceptance Test 전/후 실시

4.2. RELIABILITY (신뢰성)

- 세부과제 주관기관은 **APPENDIX H**를 만족하는 신뢰성 관리 계획을 수립하여 이행하여야 한다.
- 세부과제 주관기관은 목표로 하는 실용위성 또는 목표시장에서 포지셔닝 하고자 하는 기대목표를 충족할 수 있는 신뢰도를 제안하고, 이를 만족하도록 신뢰도예측보고서(Reliability Prediction Report)를 통해 이를 입증하여야 한다.
- 세부과제 주관기관은 고장모드, 영향 및 치명성분석(FMECA)을 수행하고 Single Point Failure, Critical Item, Limited Life Item 등을 식별하여야 한다. 세부과제 주관기관은 FMECA의 세부과제 주관기관 설계부서에서 주관하도록 업무 분장하여야 하고, Critical Item으로 식별된 항목이 적합하게 검증되는 지를 PA에서 확인하도록 업무 분장하여야 한다.
- 세부과제 주관기관은 전기전자 유닛의 경우 PSA를 수행하여야 한다.
- 세부과제 주관기관은 전기전자 유닛의 경우 WCA를 수행하여야 한다.
- 세부과제 주관기관은 실용위성 사용을 목표로 하는 장비/유닛이 Limited Life Item에 해당하는 경우, Life cycle test 프로그램 계획을 수립하고 이행하여야 한다.

4.3. SAFETY (안전성)

- 세부과제 주관기관은 **APPENDIX I**를 만족하는 안전관리 계획을 수립하여 이행하여야

한다.

4.4. MATERIAL, PART AND PROCESS CONTROL (자재/부품/공정 관리)

- 세부과제 주관기관은 **APPENDIX J**를 만족하는 자재/부품/공정관리 계획을 수립하여 이행하여야 한다.
- 세부과제 주관기관은 **Prohibited/Restricted Material**이 사용되지 않도록 설계에 반영하여야 한다. **Prohibited/Restricted Material**로 식별되는 경우 **Critical Item**으로 식별하고, **Hermitically sealing**과 같은 **Mitigation** 방안 또는 유사한 기능을 수행하는 대체 물질의 활용을 통한 **Removal** 방안 등을 조치계획을 수립하여야 한다.
- 세부과제 주관기관은 기존 실용위성 개발에서 공정역량이 확인된 기관의 공정(**KARI-approved Process or NASA/ESA Space Heritage Process**)을 최대한 활용하여야 한다. 그렇지 않은 경우, 별도의 공정검증계획서를 구체적으로 수립/제시하고 이를 공식적으로 승인받아야 한다.
- 세부과제 주관기관은 **Non-standard/Non-qualified Parts/Process**가 포함된 경우, 공정검증 및 사용가 판정을 위해 추가적인 비용/일정/시간이 소요되는 것이 검증된 우주제품의 특징임을 인지하고 이에 대한 고려를 하여야 한다.
- 세부과제 주관기관은 **DML(재료목록)**, **DMPL(기계부품목록)**, **DPL(공정목록)**을 설계완료 시점에서 공식적으로 제시하고 승인받아야 하며, 해당 내용의 정보와 도면, 작업지시서(**Shop Order, Traveler**), 작업기록, 검사기록 등의 정보가 일치하는 지를 교차 검증하여야 한다.

4.5. EEE PARTS CONTROL (전기전자부품 관리)

- 세부과제의 주관기관은 **APPENDIX K**를 만족하는 전기전자부품관리 계획을 수립하여 이행하여야 한다.
- 표준부품의 사용 : 세부과제 주관기관은 목표로 하는 **APPENDIX K** 적용시, 개발품이 저궤도위성에만 사용되는 경우 **Table K-1. EEE Part Quality For LEO**을 참조하며, 그 이외의 중궤도위성, 정지궤도위성, 달탐사 등에서 사용을 목표로 하는 경우에는 **Table K-2. EEE Part Quality For GEO**를 참조하여 표준부품을 사용하여야 한다.
- 비표준부품의 사용 : **QM**을 개발하는 경우, 표준부품과 **form, fit, function**이 동일한 비표준부품을 사용할 수 있다. 이 경우에 **part identification list**에 향후 **FM** 개발 시 사용될 부품의 부품번호와 본 과제에서 사용하는 **QM** 부품의 부품번호를 모두 기록해야 한다. 표준부품과 **form, fit, function**이 동일한 비표준부품이 없는 경우, **QM**제품에도 표준품을 사용해야 한다. 표준부품과 **form, fit, function**이 동일한 비표준부품을 사용하는 경우, 부품제조사의 시험/검사를 생략하고 수입검사만을 진행할 수 있다.
- 상용부품의 사용 : **Form, fit, function**이 동일한 표준부품이 존재하지 않는 비표준부

품은 상용부품으로 정의하며, 상용부품의 사용은 최소화해야 한다. 비용이나 개발기간 단축의 목적으로 상용부품을 사용할 수 없으며, 유사한 성능이나 기능을 갖는 표준부품이 없으며 기능을 구현하는데 불가피한 경우에만 사용이 가능하다.

- 상용부품 사용 시에는 해당 부품이 설계변경 없이 FM에도 사용될 수 있다는 것을 보증을 위하여, QM 하드웨어 제작 착수 전 해당 상용부품에 대하여 EEE-INST-002 요구사항에 따라서 screening 및 qualification이 완료되어야 한다. 만약 해당 부품에 대하여 EEE-INST-002의 screening 및 qualification 내용을 포함하는 시험성적서 또는 이와 동등한 수준의 시험성적서를 확보할 수 있는 경우 시험의 면제가 가능하다. 또한 부품 종류별로 3개씩 DPA를 수행하여야 한다.
- APPENDIX K 9.4에 명시된 특수한 부품은 EEE-INST-002가 아닌 APPENDIX K 9.4에 명시된 문서를 따라서 시험을 수행한다.
- 우주용 규격에 따른 시험 데이터가 없는 상용부품을 선정하는 경우, EEE-INST-002에 따른 시험 결과 또는 방사선 시험결과가 요구사항을 만족하지 못하면 새로운 부품을 선정해야 한다. 세부과제의 주관기관은 상용부품의 사용 시, 시험 결과가 우주부품 요구사항을 만족하지 못하면 새로운 부품의 납기 소요 및 방사선 시험 기간 소요, 설계변경 기간 소요 등으로 프로젝트 기간 내 QM의 개발 및 검증을 완료할 수 없는 리스크가 있음을 인지하여야 한다. 원칙적으로 상용부품은 불가피한 경우를 제외하고는 사용하지 않아야 하며, 상용부품을 사용하더라도 screening, qualification 및 방사선 시험 데이터가 존재하여 우주용으로 사용가능함이 알려진 부품을 선정해야 한다.
- 표준품을 포함한 모든 능동소자 부품에 대해서는 ECSS-Q-ST-60-15C 및 APPENDIX K를 따라서 radiation analysis report를 작성해야 하며, 이 때 사용하는 radiation data는 제조사에서 제공하는 데이터, 또는 최근 4년 이내에 시험결과를 인용해야 한다. 데이터 확보가 불가능한 경우 APPENDIX K의 radiation hardness 요구사항에 따라서 방사선 시험을 수행하여 데이터를 확보해야 한다.
- QM 제작 착수 전 부품의 스크리닝, Lot 수락시험 결과보고서 작성 및 radiation analysis report, part identification list 작성이 완료되어야 한다.
- Single event effect 중 부품에 영구적인 손상을 주는 효과의 LETth가 60 MeV·cm²/mg 보다 작은 경우 사용을 금지한다. Single event effect 중 부품의 오동작을 발생시키는 효과는 LETth가 60 MeV·cm²/mg 보다 작은 경우 다른 부품으로 교체를 검토하거나, 이를 억제할 수 있는 설계(필터, TMR, EDAC 등)를 구현해야 한다. Radiation analysis report에는 구현한 설계를 반영하여 연간 오동작 발생횟수를 예측하여 기술하여야 한다. 궤도환경은 개발된 과제를 통하여 제품이 사용될 것으로 예상되는 궤도를 개발기관의 책임 하에 모사하여 적용한다.
- 세부과제의 주관기관은 자체적인 PMPCB 또는 이에 준하는 회의체를 구성하여 QM에 사용되는 모든 전기전자부품에 대한 적합성 여부를 검토하여야 하며, 필요 시 스

페이스파이오니아 사업단의 요구에 의하여 회의내용 및 관련 문서를 확인할 수 있도록 관리하여야 한다.

- Part Identification List에 들어가는 내용은 ECSS-Q-ST-60C rev.2의 Annex B를 따른다.
- 세부과제의 주관기관은 **APPENDIX K**의 subcontractor와 customer 역할을 동시에 수행한다. 만약 협동연구기관(공동연구기관, 위탁연구기관 등)에서 납품받는 전기전자 부품이 있다면 이 부품에 대하여 주관기관은 customer 역할을 하며, 협동연구기관은 subcontractor 역할을 갖는다.
- 세부과제 주관기관의 전기전자부품 담당자는 상기 역할을 수행하기 위하여 ECSS-Q-ST-60C, ECSS-Q-ST-60-15, EEE-INST-002 문서 및 연관 문서의 내용을 충분히 이해하여야 한다.

4.6. CLEANLINESS & CONTAMINATION CONTROL (청정도 및 오염 관리)

- 세부과제 주관기관은 장비/유닛의 개발시 청정도를 고려한 설계하여야 한다.
- 설계 베이스라인이 청정도 요구사항과 불일치하는 경우, 설계변경 대상으로 식별하고 시정조치를 이행하여야 한다.
- 세부과제 주관기관은 사용을 목표로 하는 실용위성, 위성개발 프로세스상의 단계, 상위 서브시스템/유닛에 요구되는 적합한 청정도 및 오염관리 기준을 설정하여야 한다.
- Cleanliness Level guidelines
 - 1) Unit including Mirror, Lens, Focal Plan and Contamination critical items, handling/testing: Cleanroom class 1,000 or better
 - 2) Other unit handling/testing: Cleanroom class 100,000 or better
 - 3) General integration/assembly/testing: Cleanroom class 100,000 or better
- Outgassing (RML and CVCM) guidelines
 - 1) 최소 Outgassing 기준은 RML <1%, CVCM<0.1%으로 한다. 기준을 초과하는 경우, RFA를 작성하고 사용에 대한 정당성(Justification)을 제시하여야 한다.
 - 2) 오염민감품목 주변 자재의 Outgassing 기준은 다음을 참조한다.

Mass of material concerned(gram) around Room Temp.	CVCM (%)	RML (%)
>100	<0.01	<1
10 ~ 100	<0.05	<1
<10	<0.1	<1

Mass of material concerned(gram) below Room Temp.	CVCM (%)	RML (%)
>100	<0.01	<0.1
10 ~ 100	<0.05	<1
<10	<0.1	<1

- 세부과제 주관기관은 제작/조립/시험/보관/운송/궤도임무 기간 동안 세부과제 주관기관이 설정한 청정도 및 오염관리 기준을 만족하기 위한 관리계획을 수립하여 시행하여야 한다. 장비/유닛의 클린룸 시설 수준 및 노출시간 등이 청정도 요구사항을 만족하는 지를 확인할 책임은 세부과제 주관기관에 있다.
- 세부과제 주관기관은 조립/운송/위성체 발사장 작업에서 고려하여 할 주의사항(Precautions)과 조치방안(Provisions)을 제시하여야 한다.
- 세부과제 주관기관은 분자오염(Molecular contamination)을 저감하기 위한 조치로 수행되는 Bake-out 요건(수행시점/온도/시간) 설정하여야 한다. 오염민감품목의 경우 비행 궤도(In-orbit)에서의 교차오염(Cross-contamination)을 예방하기 위한 궤도상 Bake-out 요건을 포함하여야 한다.
- 청정도 및 오염관리 계획 수립시 **APPENDIX L**를 참조한다.

4.7. 소프트웨어 보증(SOFTWARE ASSURANCE)

- 소프트웨어 개발을 포함하는 경우, 세부과제 주관기관은 소프트웨어 보증 계획을 수립하여 시행하여야 한다. 소프트웨어 보증 계획은 PA 계획서의 일부로 작성하거나 별도 문서로 작성할 수 있다.
- 소프트웨어 보증 계획 수립시 **APPENDIX M**를 참조한다.

APPENDIX A. 제품보증 이행계획서 (PAP)의 구성

A.1 일반사항

- PAP 구성요구사항 중 "소프트웨어 보증"과 같이 개발하는 장비/유닛에 포함되지 않는 경우, 해당 절(Section)은 유지하고 비적용(Not Applicable)으로 본문에 기술한다.
- 표지를 포함하여야 한다.
- 문서관리 번호(제/개정 번호 포함)를 포함하여야 한다.
- 작성자, 세부과제 주관기관책임자(Project Manager), 제품보증책임자(PA Manager)의 서명을 포함하여야 한다.
- 목차를 포함하여야 한다.
- 제/개정 이력을 포함하여야 한다.
- 개정 이력(Rev., 제개정일자, 제/개정 내용 및 관련 문서위치(Section) 정보)를 포함하여야 한다.

A.2 구성

A.2.1. 일반사항(GENERAL)

- 작성의 목적, 목표 및 이유를 제시한다.

[주기] PAP의 목적은 세부과제 주관기관이 정한 임무목표와 관련하여 우주제품의 품질을 보장하고 해당 PA 요구사항에 적합함을 입증하기 위해 세부과제 주관기관이 이행하는 활동을 기술하기 위한 것이다. 사용을 목표로 하는 실용위성 구분, 위성개발 프로세스상의 단계, 상위 서브시스템/유닛 등에 대한 정보를 포함한다.

A.2.2. 관련 문서 및 참조문서(APPLICABLE AND REFERENCE DOCUMENTS)

2.1 관련 문서(Applicable Documents)

2.2 참조 문서(Reference Documents)

A.2.3. 제품보증 관리(PA MANAGEMENT)

A.2.3.1 제품보증 조직/인력 및 업무분장(PA Organization/Personnel and Activities)

- 본 문서의 본문 "제품보증 계획(PA program planning)" 요구 사항을 충족하기 위해 적용할 활동, 프로세스 및 절차를 제시한다. 조직/인력(책임과 권한 포함)을 포함하여야

한다.

[주기] 해당 제품보증 요구 사항을 충족하기 위해 개발기과에서 적용할 활동, 프로세스 및 절차를 제시한다.

A.2.3.2 제품보증 이행(PA Implementation)

본 문서의 본문 "제품보증계획 이행(PA Plan Implementation)" 요구 사항을 충족하기 위해 세부과제 주관기관에서 적용할 활동, 프로세스 및 절차를 제시한다.

A.2.3.3 품질보증(Quality Assurance)

품질보증을 이행하기 위해 세부과제 주관기관에서 적용할 활동, 프로세스 및 절차를 제시한다.

A.2.3.4 신뢰성(Reliability)

신뢰성 요구사항을 충족하기 위해 적용할 활동, 프로세스 및 절차를 제시한다.

A.2.3.5 안전성(Safety)

안전 요구사항을 충족하기 위해 세부과제 주관기관에서 적용할 활동, 프로세스 및 절차를 제시한다.

A.2.3.6 전기전자부품(EEE Parts)

EEE 부품 요구사항을 충족하기 위해 세부과제 주관기관에서 적용할 활동, 프로세스 및 절차를 제시한다.

A.2.3.7 소재 및 공정(Materials and Process, M&P)

재료 및 공정 요구사항을 충족하기 위해 세부과제 주관기관에서 적용할 활동, 프로세스 및 절차를 제시한다.

A.2.3.8 소프트웨어 품질보증(Software Assurance)

소프트웨어 보증 요구사항을 충족하기 위해 세부과제 주관기관에서 적용할 활동, 프로세스 및 절차를 제시한다.

A.2.3.9 청정도 및 오염관리(Cleanliness and Contamination Control)

청정도 및 오염관리 요구사항을 충족하기 위해 세부과제 주관기관에서 적용할 활동, 프로세스 및 절차, 시설을 제시한다.

APPENDIX B. PA 현황보고서 (PA STATUS REPORT) 포함내용

B.1 구성

B.1.1 PA Status Report 문서번호, 개정이력(Rev.000), 보고일자

B.1.2 Milestone status (이행일자, 회의록 관리번호)

- Kick off Meeting, Design Review, MRR, TRR, PTR, PSR

B.1.3 EEE Part status

- 미승인 부품 status(mitigation plan 포함)
- DCL 문서 발행 현황(작성 및 개정 Rev.)
- Part Approval Document of EEE Part (PAD)

B.1.4 Material, Mechanical Part, Process status

- 미승인 자재/부품/공정 status(mitigation plan 포함)
- Request for Approval of M&P(RFA)
- DML 문서 발행 현황(작성 및 개정 Rev.)
- DMPL 문서 발행 현황(작성 및 개정 Rev.)
- DPL 문서 발행 현황(작성 및 개정 Rev.)

B.1.5 Nonconformance status

- 사내 별도관리 되는 경우, 관리문서번호로 표시

B.1.6 KIP/MIP status

B.1.7 Critical Items (including mitigation plan status)

B.1.8 PA Documentation Status

- FMECA 문서 발행 현황(작성 및 개정 Rev.)
- PSA 문서 발행 현황(작성 및 개정 Rev.)
- WCA 문서 발행 현황(작성 및 개정 Rev.)

B.2 참조

B.2.1 EEE Part status

B.2.2 Material, Mechanical Part, Process status

- 공정검증 대상 식별 및 진행현황
- 공정검증 식별 현황, 추가적인 공정검증이 필요한 공정 진행현황을 관리하여야 한다. 실용위성에서 검증된 이력이 없는 시설/기관에서 이행되는 공정은 비승인 공정으로 판단되어야 하며, 적절한 공정검증 표준에 따라 공정검증 계획 수립, 계획에 따른 검증 진행, 결과보고서의 작성을 통해 공정의 적합성을 확보하여야 한다.
 - a. 공정검증 기준으로 사용되는 표준서의 식별
 - b. 공정검증 기준에 따른 적절한 시설, 장비의 식별
 - c. 공정검증 기준에 따른 시편, 시험종류 및 절차, 검사 종류 및 절차 식별
 - d. 공정검증 기준에서 정한 기준을 만족하는 결과에 대한 판단

B.2.3 Nonconformance status

세부과제 주관기관의 NCR 관리체계에 따라 발생 이력/조치현황 관리

B.2.4 KIP/MIP status

작성문서현황: 계획된 자주검사(KIP, Key Inspection Points)에 따라 이행한 검사결과 현황 및 생성된 검사보고서 목록(일자, 관리번호, 검사결과 등)

APPENDIX C. 제품보증 양식 (FORMS)

This section describes the minimum information should be included in the PA forms. The Subcontractor can use his own report form if his form includes all the contents of the template provided in this Section.

C.1. 변경제안서 (Change Proposal)

Change Proposal shall include at least following information:

- 1 : Document number for change proposal
- 2 : Title of change proposal
- 3 : Applicable CI number
- 4 : Applicable model type (FM, PFM, EM, etc.)
- 5 : Applicable serial number
- 6 : Class of change (class 1, class 2)
- 7 : Affected documents due to this change
- 8 : Price influence due to this change
- 9 : Schedule influence due to this change
- 10 : Description of changes
- 11 : Reasons for changes
- 12 : Subcontractor's CCB approval
- 13 : KARI's CCB approval

C.2. 면제요청서 (Request for Waiver)

- 1 : Document number for RFW
- 2 : Title of RFW
- 3 : Applicable part number
- 4 : Applicable model type (FM, PFM, EM, etc.)
- 5 : Applicable serial number
- 6 : Document number of drawing or specification for applicable product
- 7 : Description of RFW
- 8 : Reasons for RFW
- 9 : Any adverse effect expected due to this waiver
- 10 : Document number for applicable nonconformance report
- 11 : Subcontractor's MRB approval

12 : KARI's MRB approval

C.3. 완화요청서 (Request for Deviation)

- 1 : Document number for RFD
- 2 : Title of RFD
- 3 : Applicable part number
- 4 : Applicable model type (FM, PFM, EM, etc.)
- 5 : Applicable serial number
- 6 : Part number of next assembly
- 7 : Document number of drawing or specification for applicable product
- 8 : Description of RFD
- 9 : Reasons for RFD
- 10 : Any adverse effect expected due to this deviation
- 11 : Document number for applicable nonconformance report
- 12 : Subcontractor's CCB approval
- 13 : KARI's CCB approval

C.4. 부적합보고서 (Nonconformance Report)

- 1 : Document number for nonconformance report
- 2 : Title of nonconformance report
- 3 : Applicable part number
- 4 : Applicable model type (FM, PFM, EM, etc.)
- 5 : Applicable serial number
- 6 : Description of nonconformance
- 7 : Classification of nonconformance (major, minor)
- 8 : Cause of nonconformance
- 9 : Subcontractor's MRB disposition proposal
- 10 : Any corrective actions proposed by Subcontractor's MRB
- 11 : Subcontractor's MRB approval
- 12 : KARI's MRB approval

C.5. 전기전자부품 식별목록 (PID ; EEE Part Identification List)

- 1 : Part number (commercial equivalent designation)
- 2 : Family
- 3 : Part type or Electrical function

- 4 : Package
- 5 : Value or range of values with tolerance for non-qualified parts (optional)
- 6 : Description of the part
- 7 : Component manufacturer / Country
- 8 : Generic procurement specification
- 9 : Detail procurement specification (with issue and revision for non-qualified parts/commercial parts)
- 10 : Specification amendment (including issue and revision),
- 11 : Name of the procurement agent (CPPA, supplier, distributor),
- 12 : Quality level and lot test (ESCC LAT or LVT, MIL TCI or QCI or CI),
- 13 : Space qualified status (yes or no),
- 14 : RVT (yes or no),
- 15 : Reference of the PAD or Justification Document, where required,
- 16 : Approval status of the part,
- 17 : Change identification between each PIL issue,
- 18 : Date-code (only for as-built PIL).

C.6. 부품승인문서 (PAD ; Part Approval Documents)

- 1 : Doc No - Unique sequential number
- 2 : Issue of document
- 3 : Date of issue
- 4 : Name of project using the part
- 5 : Name of the person submitting the PAD
- 6 : Name of the company submitting the PAD
- 7 : Family - Capacitor, resistor, etc.
- 8 : Group - Ceramic, tantalum, etc.
- 9 : Part Number in accordance with the procurement specification. It may be generic to cover different range of parts. (e.g. range of resistors or capacitors or variants for connectors & accessories)
- 10 : Commercial Equivalent Designation
- 11 : Technology/Characteristics - Additional details of the components covered by the PAD
- 12 : Pure tin free (Y/N) When tin $\geq$ 97% (inside the component and terminations)
- 13 : Generic specification
- 14 : Detail specification with issue and revisions only required for non-qualified parts
- 15 : Specification Amendment Relevant specification with issue and revisions

- 16: Quality level as defined in Section K.
- 17: Procurement by - Identify the name of the company procuring the part. This can be Subcontractor himself, CPPA, distributor, or a combination thereof.
- 18: Manufacturer/Country
- 19: Approval status - Information about known approvals (EPPL, ESCC, ESCC/QML, MIL, MIL/QML, or other approvals / previous usage.)
- 20: Evaluation program required - Y/N as applicable
- 21: Procurement inspections and test - Y/N as applicable
- 22: DPA sample size
- 23: Complementary tests Testing/Inspection in addition to that defined in the procurement specification shall be identified, e.g. PIND, up screening,
- 24: Lot Acceptance - Identify level and subgroups
- 25: Radiation Hardness Data for Total Dose.
- 26: Radiation Hardness Data for SEL / SEU / SET / SEFI / SEB / SEGR, others – LET_{th} and Cross-section, etc.
- 27: Evaluation Test Data reference - Reference of the test report for Total Dose, Single Event Latch up / Single Event Upset / Single Event Transient / Single Event Functional Interrupt / Single Event Burn out / Single Event Gate Rupture. Radiation test report shall include data source information.
- 28: RVT Radiation Verification Test - Y/N as applicable
- 29: Remarks - Any additional information
- 30: Approval customer - Signature signifies acceptance
- 31: Approval first-level supplier

C.7. 구매규격 (Procurement Specification)

- 1 : A description of the purpose, content and the reason prompting its preparation,
- 2 : A list of the applicable and reference documents,
- 3 : Any additional terms, definitions or abbreviations,
- 4 : Absolute maximum ratings,
- 5 : Electrical and mechanical parameters and limits,
- 6 : Screening, burn-in, and acceptance requirements,
- 7 : Package material and lead finish,
- 8 : Documentation/data requirements,
- 9 : Delta limits when applicable,
- 10 : Criteria for percent defective allowable,

- 11 : LAT or LVT, QCI or TCI,
- 12 : Marking,
- 13 : Storage requirements,
- 14 : Requirements for lot homogeneity,
- 15 : Serialization (when applicable),
- 16 : Protective packaging and handling requirements,
- 17 : Radiation Verification Testing requirements, when applicable.

C.8. 승인요청서 (Request for Approval)

- 1 : Document number for materials approval document
- 2 : Category of the material (adhesive, screw, etc.)
- 3 : Chemical nature of the material
- 4 : Material name
- 5 : Manufacturer
- 6 : Document number of generic specifications
- 7 : Document number of detail specification
- 8 : Specification amendment information
- 9 : Quality level of the material
- 10 : Compliance status to the program requirements
- 11 : Reference of applicable qualified part list
- 12 : Heritage program information
- 13 : Environmental condition of application
- 14 : Document number of applicable process specification
- 15 : Description of application
- 16 : Rational for application of the material (In case of noncompliant material)
- 17 : Plan for supplementary verification
- 18 : Deliverable documents list
- 19 : Subcontractor's MPCB approval
- 20 : KARI's PMPCB approval

C.9. 재료 식별목록 (Materials Identification List)

- 1 : Document number for materials identification list
- 2 : Part number of EI
- 3 : Revision status
- 4 : Part number of the material

- 5 : Materials name
- 6 : Description of the material
- 7 : Document number of specifications
- 8 : Chemical nature of the material
- 9 : Application purpose
- 10 : The location where the material is used
- 11 : TML characteristics
- 12 : CVCM characteristics
- 13 : Reference of outgassing information
- 14 : Document number of applicable process specification

C.10. 공정 목록 (Process List)

- 1 : Document number for process list
- 2 : Part number of EI
- 3 : Revision status
- 4 : Name of the process
- 5 : Description of the process
- 6 : Document number of process specification
- 7 : Main parameter of the specification
- 8 : Application Purpose
- 9 : The location where the material is used
- 10 : Flight materials used in the process
- 11 : Process heritage or qualification information

APPENDIX D. 프로그램 검토회의 (PROGRAM REVIEW) 수행

The Subcontractor shall maintain a review process for the End Product. This review process will consist of Design Reviews, MRR, TRR, and PSR.

The Subcontractor shall notify Customer (Satellite System Integrator) of the agenda 15 working days before scheduled meeting.

In case Customer (Satellite System Integrator) participates in the reviews, Customer (Satellite System Integrator) shall have the right to make a “Go” or “No Go” decision.

Meeting minutes and action items from the reviews shall be documented and provided to Customer (Satellite System Integrator).

D.1. DESIGN REVIEWS

The PDR and CDR shall evaluate the ability of the End Product to meet the program requirements such as PAR, equipment specification, and interface control documents.

For the End Product which is already developed and qualified in the previous program, ESR may substitute for Design Reviews.

During the review process, at least the following information shall be provided:

- a. Compliance status to the design requirements including qualification status
- b. Schematics or major characteristics of the design
- c. Analysis results

D.2. MANUFACTURING READINESS REVIEW

The MRR shall evaluate the preparedness of the Subcontractor's manufacturing processes for fabricating the End Product to the standards described by this PAR. During the review process, at least the following information shall be provided:

- a. Configuration status
- b. Manufacturing flow and instruction for critical process
- c. Any design changes from the CDR baseline

D.3. TEST READINESS REVIEW

The TRR shall evaluate the preparedness of End Products and the Subcontractor's processes for the testing of End Product to the applicable specifications. During the review process, at least the following information shall be provided:

- a. Configuration status

- b. Nonconformance status
- c. Compliance Matrix which shows test criteria and specification requirements
- d. Test procedures

D.4. PRE-SHIP REVIEW

The PSR shall evaluate compliance to the applicable requirements and the completeness of the activities required by the contract. During the review process, at least the following information shall be provided:

- a. Summary of open actions during contract period
- b. Requirement compliance status
- c. EIDP documents
- d. Configuration status
- e. Nonconformance status
- f. Acceptance test and analysis results
- g. Contractual deliverable status
- h. Visual inspection of the End Product

D.5. ASSURANCE STATUS REPORTS

The Subcontractor shall report periodically on the status of the PA Program as part of the progress report. The following subjects shall be addressed in the progress report as appropriate:

- a. Significant or unsolved PA issues
- b. Summary of waiver and deviation requests
- c. Summary of nonconformance and failures
- d. Summary of configuration changes
- e. Summary of key inspection and test activities
- f. Status summary of PAD, RFA, and nonconventional processes
- g. Change summary of EEE part, materials, and processes list
- h. Results of trend analyses and alerts surveys
- i. Status of procurement and Supplier's PA Program

APPENDIX E. 부적합관리 (NONCONFORMANCE CONTROL)

E.1. GENERAL

The Subcontractor shall establish and maintain a nonconformance control system in order to track nonconformances systematically and to prevent reoccurrence. The system shall provide a disciplined approach to the identification and segregation of nonconforming items, recording, reporting, review, and disposition of nonconformances, and the implementation of corrective actions.

Overstress analyses are required for nonconformances which occur during the unit test or during operation susceptible to overstress of other components.

All nonconformances shall be closed prior to product shipment.

E.2. NONCONFORMANCE

E.2.1. Nonconformance Classification

Nonconformances shall be classified into minor or major on the basis of the severity of their consequences.

Major nonconformances are those with possible impact on:

- A. Unit performance including life duration, environmental compatibility, etc.
- B. Unit interfaces or environmental characteristics such as thermal, vibration, RF, EMC, etc.
- C. Unit reliability, especially due to the part problem.
- D. Unit operation such as impacts on the operation manual, additional operational constraints, etc.

Disposition of the major nonconformances shall be submitted to Customer (Satellite System Integrator)'s MRB for review and approval before implementation.

Minor nonconformances are all other nonconformances which are not classified as major.

Minor nonconformances may be disposed and implemented at Subcontractor level, but it's disposition status shall be provided for Customer (Satellite System Integrator) with the Nonconformance Status List.

E.2.2. Nonconformance Report

Nonconformance shall be recorded directly on formal report forms at the time of observation. Interim records such as scratch pads and notebooks are prohibited. Voiding of a recorded discrepancy shall be accomplished without destruction of the record or its legibility.

A nonconformance report shall contain sufficient data for the complete identification of non-conforming item, the description of nonconformances, the status of related actions, and analysis of nonconformances.

In case of minor nonconformances, the Subcontractor may use his own document form and control system. But in case of major nonconformances, the Subcontractor's report shall include all the contents provided in APPENDIX C.

The inspection status and identification of nonconforming items shall be documented at the point and time of discovery in the item's document folder and shall be immediately subject to review.

List of all nonconformances and the major nonconformance report shall be submitted to Customer (Satellite System Integrator) and all nonconformance report shall be kept available by Customer (Satellite System Integrator) at the Subcontractor's facilities.

E.3. MATERIAL REVIEW BOARD

Major nonconformances shall be reviewed and disposition taken by a formal MRB, established at all contractual levels.

A member of the Subcontractor's PA organization shall act as chairman. And an approved member of the Subcontractor's engineering organization shall be responsible for reviewing the nonconformances and making decisions on the engineering aspects of such nonconformances.

The Subcontractor's MRB shall submit the review results of major nonconformances to Customer (Satellite System Integrator)'s MRB with the proposed disposition for approval by Customer (Satellite System Integrator)'s MRB.

E.4. NONCONFORMANCE STATUS LIST

The Subcontractor shall maintain the list of nonconformances for the contracted item. This list shall identify the status of each nonconformance.

The status of all nonconformances shall be reported to Customer (Satellite System Integrator) through assurance status reports.

E.5. ALERT INFORMATION

The Subcontractor shall provide Customer (Satellite System Integrator) with selected alerts that document problems related with deliverable flight item as reported by the GIDEP, ESA alert, or the equivalent from the Subcontractor's country, if applicable.

APPENDIX F. 형상관리 (CONFIGURATION MANAGEMENT)

다음은 국내 실용위성에서 요구하고 있는 형상관리 요구사항의 예시이다. 위성 시스템 레벨의 피드백은 개별 위성개발 과제와 연동되어야 하므로 본 과제의 범위를 넘어서나. 세부과제 주관기관은 본 과제에서 이행되지 않는 부분에 대해서는 모사 검증 등 적절한 대안을 수립하여 시행한다.

[주기] Subcontractor는 세부과제 주관기관으로 해석한다.

[주기] 납품은 개발종료로 해석한다.

국내 실용위성급 형상관리 요구사항의 예시는 다음과 같다.

F.1. GENERAL

The Subcontractor shall maintain a Configuration Management program to identify CIs, to control any changes, and to account for the configuration status of each CI.

The Subcontractor shall appoint a person to be responsible for the implementation, operation and monitoring of the program configuration and data management.

F.2. CONFIGURATION IDENTIFICATION

Configuration identification shall incrementally establish and release controlled documentation for the purpose of identifying configuration characteristics of the End Item until it is fully defined with respect to its intended functional, performance and physical characteristics, thereby ensuring the continuous integrity of the product configuration.

Documents necessary for Configuration Identification shall be presented at the Subcontractor's key review described in Section 3.5. If the documents are approved, this will form the configuration baselines.

The CIs shall be developed and maintained through distinct sequential levels of detail:

- a. The functional baseline is identified by the overall performances, interfaces, and design requirements. The contract, equipment specification by Customer (Satellite System Integrator), and SOW shall consist of a functional baseline. This baseline will be established at the contract.
- b. The development baseline is identified by the technical specifications written by the Subcontractor for his top level and lower level CIs to satisfy the functional baseline requirements. The Subcontractor's development specifications and engineering documents at Design Reviews shall consist of a development baseline. This baseline will be

established at Design Reviews.

- c. The production baseline is identified by the released detailed solution for FM production, testing, and operation. Drawings, associated lists, and work instructions together with test procedures shall consist of a production baseline. This baseline will be established at MRR. Baselines and approved changes from those baselines constitute the current configuration identification.

F.3. CONFIGURATION CONTROL

The Subcontractor shall maintain a configuration control system by which, any change or relaxation to the configuration identification of a CI after formal establishment of its baselines, will be identified, evaluated, classified, justified, approved and implemented or rejected.

F.3.1. Change Classification

Any change between Customer (Satellite System Integrator) and the Subcontractors shall be classified into Class 1 or Class 2. The criteria for change classification are described herein.

Class 1 changes impact the contractual or technical agreement reached between Customer (Satellite System Integrator) and the Subcontractor. In particular, any of the following changes will have a definite impact on the agreement:

- a. Functions, performances, and weight as defined in the contract, specifications, and SOW requirements
 - b. Safety, reliability, and maintainability
 - c. Interface control requirements
 - d. Interchangeability of any item if the item has already been delivered
 - e. Any delivered technical manuals
 - f. Costs and schedule
- Class 1 changes shall be submitted to Customer (Satellite System Integrator)'s CCB for review and approval before implementation.
 - Class 2 changes are those which are not classified as Class 1, but those are necessary to meet technical and contractual requirements and provisions.
 - Class 2 changes may be implemented after Subcontractor's CCB approval, but shall be forwarded to Customer (Satellite System Integrator) for information.

F.3.2. Configuration Control Board

The Subcontractor's CCB, chaired by the program manager or his designee, shall be responsible for the following activities:

- a. Review, evaluate, classify, and process all changes proposed.
- b. Direct activities to accommodate Customer (Satellite System Integrator)'s change requests.
- c. Direct activities necessary to implement approved changes.

The Subcontractor's CCB authority, membership, and procedures shall be defined in the PA Program Plan.

F.3.3. Change Documentation

The Subcontractor may initiate the change procedure with the following change documents:

- a. Change Proposal : The document used by the Subcontractor, either in response to a Change Request or on its own initiative, to propose a change in the current approved configuration identification.

In case of a Class 2 change proposal, the Subcontractor may use his own document form and control system. But in case of a Class 1 Change Proposal, the Subcontractor's form shall include all the contents provided in APPENDIX C, and shall contain all information, drawings, and justifications.

The Class 1 Change Proposal shall be submitted to Customer (Satellite System Integrator)'s CCB for approval.

- b. Request for Waiver (RFW) : This aims to cover a nonconformance discovered during manufacturing or test of an item, which has been proposed suitable for use by the Subcontractor's MRB. This shall be submitted with a nonconformance report and MRB dispositions.
- c. Request for Deviation (RFD) : This will be submitted to depart from a requirement, prior to manufacture and test of an item. When approved, deviations will be part of the configuration baseline of the CIs.

Incorporation of changes into any document shall be carried out by the Subcontractor responsible for the issuing of the document.

The document change log sheet shall clearly identify references to Change Proposals.

F.4. INTERFACE CONTROL DOCUMENTS

For each End Product, the Subcontractor shall provide Customer (Satellite System Integrator) with ICDs including as a minimum the following:

- a. Electrical ICD : Power, primary secondary switching diagrams, protection characteristics of each function, connectors list and electrical characteristics of the signals on each pin of each connector, etc.
- b. Command and Telemetry ICD : Command and telemetry characteristics, points, type,

mnemonics, transfer function, bits and status meaning, etc.

c. Mechanical ICD : Geometry, dimensions, fixings, weight, inertia, and position of center of gravity, etc.

d. Thermal ICD : Thermal characteristics.

When approved by Customer (Satellite System Integrator), ICD become a requirement for the Subcontractor. Then, any change to approved ICDs shall be processed as a Class 1 change.

At lower levels, any Lower Tier Subcontractor having design authority over an interface between CIs is responsible for the control of those interfaces and required to establish ICDs to control them.

F.5. CONFIGURATION STATUS ACCOUNTING

The Subcontractor shall implement a status accounting system capable of maintaining and verifying the configuration and change status of all deliverable equipment for which he has design responsibility.

The major elements to be provided are the following documents:

- a. CIDL : The CIDL shall describe current issue and revision of documents and approved changes. CIDL shall include :
 - Basic CI information
 - Requirements data list : Documents concerning the functional baseline.
 - Specifications data list : Documents concerning the development baseline
 - Design data list : Documents concerning the production baseline.
 - Operations support data list such as transportation, handling, storage, installation, operation, calibration, maintenance, users manuals, etc.
- b. ABCL : The ABCL will list the relevant applicable production baseline and the approved waivers for this baseline, and will establish the actual composition of the CI by hardware identification number.

F.6. CONFIGURATION VERIFICATION

The Subcontractor is responsible for the configuration verification of each deliverable CI:

- a. Comparison between the as designed configuration and the as-built and tested configuration
- b. Justification of any differences

Customer (Satellite System Integrator) will verify configuration of a CI during program reviews and MIP.

F.7. DOCUMENTATION MANAGEMENT

The Subcontractor shall establish a data center and maintain applicable data during the mission life of the End Product.

Each Subcontractor shall maintain a documentation management system to:

- a. Maintain a database for all documents produced under the contract,
- b. Verify that all documents required in the SOW are produced and delivered,
- c. Introduce approved changes in the baseline documents,
- d. Set up a receipt, recording, and dispatch system for all the program documents.

For each document, a change log sheet shall be provided to list the different issues with dates, information about the reason for modification or the incorporated Change Proposal.

APPENDIX G. 품질보증 (QUALITY ASSURANCE)

G.1. GENERAL

The Subcontractor shall maintain a QA system consistent with ISO 9001 or equivalent standards.

Customer (Satellite System Integrator) shall have the right to verify conformity of the Subcontractor's Quality System or to verify the product in accordance with the specified requirements at the Subcontractor's facilities and/or his Supplier's facilities.

G.2. QUALITY ASSURANCE SYSTEM

G.2.1. Quality Assurance Program

The Subcontractor shall implement and maintain a QA program to ensure that appropriate quality requirements are established and implemented to verify progress and to ensure prompt detection and correction of deficiencies. This program shall include the items manufactured or processed by the Subcontractor, as well as items procured from Suppliers or Lower Tier Subcontractors.

Design rules and methods shall be consistent with this PAR. Fabrication, integration, testing, and maintenance are conducted in a controlled manner such that the End Item conforms to the applicable requirements.

The Subcontractor shall prepare a Quality Manual covering the requirements of this document. The Quality Manual shall include or reference the Quality System procedures.

The Supplier and Lower Tier Subcontractor shall ensure that the Quality System procedures are readily available to Subcontractor's personnel, who are responsible for ensuring compliance with requirement, and to Customer (Satellite System Integrator).

G.2.2. Organization

A QA manager shall be assigned and shall manage the program to ensure compliance with quality requirements outlined in this PAR.

The Subcontractor shall define and document the responsibility and authority of personnel who perform work affecting quality for ensuring that the Quality System is established, effectively implemented, and maintained.

G.2.3. Personnel Training

The Subcontractor shall maintain a training program to ensure adequate skill level conforms to End Product requirements. Training shall be emphasized for the tasks which affect the quality and reliability of the End Product being procured.

Training records for personnel affecting quality shall be maintained.

G.2.4. Personnel Certification

The Subcontractor shall maintain a system of personnel certification covering activities such as welding, soldering, connector assembly, assembly, bonding, potting, plating, cleaning, NDT, and other activities requiring special skills. Only certified personnel shall perform the above activities. The certification shall be issued in accordance with applicable MIL, ESA, or equivalent specifications.

G.3. PURCHASING AND PROCUREMENT

The Subcontractor shall establish adequate controls for the procurement of hardware, software, and services. The control of procurement activity includes selection of procurement sources, control of purchase documents, surveillance of Suppliers and control of incoming items.

G.3.1. Supplier and Lower Tier Subcontractor Control

The Subcontractor shall impose the requirements in this PAR on his Suppliers and Lower Tier Subcontractors as appropriate.

The Subcontractor shall be responsible for implementing and maintaining an effective system of control over his procurement sources to ensure that hardware, software, and services purchased for the program meet the requirements outlined in this PAR.

The Subcontractor shall ensure that all purchased special processes and personnel are properly certified in accordance with the requirements of this PAR.

G.3.2. Source Inspection

The Subcontractor shall exercise surveillance over all the activities carried out by his Suppliers and Lower Tier Subcontractors during the contract period.

The Subcontractor shall ensure that each of his Suppliers implements adequate surveillance over their lower level Suppliers, in accordance with this PAR.

Purchased products shall be verified upon receipt or at his Supplier's facility before shipment.

G.3.3. Procurement documents

The Subcontractor shall ensure that supplies are precisely identified and that all applicable requirements are properly defined in the procurement documents.

The Subcontractor shall ensure that requirements contained in lower tier procurement documents are traceable and can be demonstrated.

G.4. PRODUCT TRACEABILITY

G.4.1. Product Identification and Traceability

The Subcontractor shall establish and maintain documented procedures for identifying a product or lot by suitable means from receipt and during all phases of production, delivery, and installation. All similar assemblies and subassemblies shall be serialized.

The Subcontractor's system shall be capable of retrieving the identification and serialization record at the subassembly level. It shall also be capable of retrieving fabrication and test records of identifiable articles, materials, and parts in the event verification of the articles, materials, or parts becomes necessary.

G.4.2. Photographic Identification

Prior to final closure of subassemblies and assemblies, a color photograph shall be taken to identify the location and presence of parts therein.

The photograph shall be of sufficient clarity to enable the viewer to readily identify part identification and location. The photograph shall be identified with the applicable part number, revision, serial number, and date.

If the assembly is reopened for rework or adjustments and the validity of the photograph affected, an additional photograph shall be taken.

A copy of these photographs shall be included in the EIDP.

G.5. INSPECTION AND TEST

The Subcontractor shall plan inspections and tests during manufacturing, assembly and integration process where maximum assurance for correct processing and prevention of unrecoverable or costly nonconformance can be obtained.

The Subcontractor shall perform formal inspection at critical process, called KIP inspections. These shall verify that all the actions have been completed and the product satisfies applicable requirements.

Among the inspections and tests, some selected inspections which is critical to performance

and schedule, shall be performed by Customer (Satellite System Integrator) . This is called MIP inspection. MIP inspection plan shall be agreed with Customer (Satellite System Integrator) and described in the manufacturing flow diagram.

G.5.1. Receiving Inspection and Test

The Subcontractor shall perform receiving inspections and tests to verify that parts and materials conform to the requirements of this PAR. The Subcontractor shall inspect the product to ensure that it conforms to applicable procurement document.

Receiving inspection shall be performed in accordance with a pre-planned checklist. The checklist shall describe item characteristics and its expected criteria.

G.5.2. In-Process Inspection and Test

The Subcontractor shall perform in-process inspection and test surveillance operations to verify compliance with engineering and manufacturing requirements.

Inspection shall be planned at points in the fabrication and test cycle where subsequent manufacturing operations would make any previous operations difficult to inspect.

Each inspection points shall be defined as a specific step in the assembly traveler documents. Among these inspections, KIP/MIP shall be described in the manufacturing flow diagram. And the Subcontractor shall notify Customer (Satellite System Integrator) of KIP/MIP event.

Prior to shipment, the Subcontractor shall perform formal inspections and tests of End Products to ensure that they conform to applicable drawings and specifications with respect to configuration, performance, construction, workmanship, and identification.

Test equipment and setups shall be verified to be of proper configuration as required by the test procedure and to have valid calibration and certification status.

The Subcontractor shall establish controls which shall identify and physically segregate rejected items from conforming items. Also, he shall establish controls for conditionally accepted items which will allow tracking through assembly and, if required, retrieval of such items to prevent shipment in the End Product.

G.5.3. Acceptance Test

The Subcontractor shall perform acceptance test to verify compliance with contractual performance requirements.

Acceptance test shall verify environmental compatibility of the End Product as required by contract documents.

Acceptance test result shall be certified by the Subcontractor Quality Manager and approved by

Customer (Satellite System Integrator) before unit shipment.

G.5.4. Equipment Calibration

The Subcontractor shall maintain a calibration system in accordance with the applicable MIL or ESA requirements.

Records of calibration shall be maintained and made available for review by Customer (Satellite System Integrator) upon request.

G.6. CONTROL OF FABRICATION

G.6.1. Work Instruction

The Subcontractor's production operations shall be accomplished through controlled and documented work instructions. This instruction shall be clear, complete, and current and shall indicate the proper methods, tooling, location, and equipment required to accomplish the work. In case specific process specification is applicable, the instruction shall follow applicable specification.

Work instruction for the hardware assembly will be a traveler document.

Applicable instructions and aids shall be located in the work areas and personnel shall be familiar with the pertinent contents.

The Subcontractor Quality System shall provide for effective review and update of work instructions and specifications to assure compliance with contract requirements.

G.6.2. Manufacturing Flow Diagram

For each type of deliverable End Product, the Subcontractor shall prepare and maintain a manufacturing flow diagram identifying manufacturing and inspection operations.

The Subcontractor shall establish the KIP and MIP on the manufacturing flow diagram and provide this to Customer (Satellite System Integrator) for concurrence. These shall include visual as well as mechanical inspections and tests as appropriate.

G.6.3. Manufacturing Flow Control

In order to ensure quality uniformity, the following practices shall be implemented by the Subcontractor and his Suppliers:

- a. In general, once installed and inspected, a piece part, other than mechanical fasteners, shall not be reinstalled in deliverable hardware.
- b. An inspection per process specification and drawing requirements shall be performed and a

surveillance of equipment and personnel certification and compliance with process specifications instructions will be checked on a periodic basis.

- c. Store surveillance shall be performed to verify that handling, packaging, and environmental requirements is complied, and to verify that part type segregation is being implemented.
- d. Completed work shall be inspected prior to cover-up the assembly and prior to assembly traveler closeout as a minimum. Major inspection points shall be delineated in flow diagrams for electronic hardware.
- e. Special verification of polarized capacitors is required prior to power on. In addition, polarity shall be verified by voltage measurement at first power on. All capacitors require discharging before installation.
- f. All feed through filters shall be tested for insulation resistance after installation and the actual reading recorded on the assembly traveler.
- g. Threaded fasteners shall be torqued to the values specified on assembly drawings or travelers.
- h. All socket contacts shall have the separation force measured and all removable type contacts shall have a contact retention test performed to be assured of locked in contacts. Separation forces for all connector types shall be measured after conditioning.
- i. ESD protective dust caps shall be installed and delivered on external connectors. For high sensitivity ESD units, grounded shorting plugs are suggested.
- j. Flight hardware connectors which interface to GSE shall be protected by connector savers.
- k. The Subcontractor shall maintain accountability and configuration control of all parts during all phases of production.

G.6.4. Handling

The contractor shall prevent handling damage during all phases of manufacturing, assembly, integration, testing, storage, transportation and operation, through the use of followings:

- a. Protective measure during handling,
- b. Handling devices, and
- c. Procedures and instructions.

G.6.5. Storage

The contractor shall have secure storage areas available for:

- a. Incoming materials,
- b. Intermediate items needing temporary storage, and
- c. End Items before shipping.

Limited-life materials, suspended limited-life materials, nonconforming items awaiting MRB disposition, scrap items and all other items which are designated to be stored separately for health or safety reasons, shall be placed in segregated areas within the storage area. Each segregated area within the stores shall be clearly identified and labeled.

Controls shall be maintained over acceptance into and withdrawal from the storage area. Records shall be maintained to ensure that all stored items are within the usable life limits and adequately controlled and retested, and to provide traceability within the storage area.

G.6.6. Preservation

The Subcontractor shall ensure that items subject to deterioration, corrosion or contamination through exposure to air, moisture or other environmental elements are preserved by methods that ensure maximum protection consistent with life and usage.

G.6.7. Packaging

The container and packaging condition shall protect delivered hardware from the external environmental variation or events. The packaging condition for transportation shall consider the following items:

- a. ESD protective measure for the electronic End Product
- b. Environmental monitoring provisions such as humidity, shock, etc.
- c. Use of double bag to maintaining cleanliness
- d. Subcontractor's QA seal after final inspection before shipment
- e. Use of reusable container box is recommended.

G.6.8. Electrostatic Discharge Control

The Subcontractor shall implement an ESD control program based on the requirements of MIL-STD-1686 and MIL-HDBK-263 as a guide. All ESD sensitive parts shall be shipped in protective packages with clear indication of the part's ESD sensitivity.

Handling and protective procedures are to be documented in the Subcontractor's fabrication, inspection and process procedures. Procedures shall have instructions for the use of equipment, tools and materials, operating guidelines, approved packaging materials, and ESD controlled workstation requirements for the handling and protection of ESD sensitive electronic parts.

G.7. END ITEM DATA PACKAGE

The Subcontractor shall prepare legible and reproducible EIDP for each deliverable End Item under the contract as described by this PAR. Each EIDP shall be reviewed by Subcontractor

personnel for accuracy, content, and legibility prior to submittal to Customer (Satellite System Integrator).

The major contents of the EIDP shall be submitted to Customer (Satellite System Integrator) for review at least 10 working days prior to the PSR.

During the PSR, the EIDP shall be presented to a Customer (Satellite System Integrator) representative for review along with the deliverable item and shall be approved by review members. The PSR shall be held after final acceptance of the item by the Subcontractor QA and prior to shipment.

Final acceptance of the item shall be contingent upon the acceptability of the EIDP at Customer (Satellite System Integrator).

Each data package shall be bound, divided into these sections and completed in this order:

- a. Title page containing End Item description, Customer (Satellite System Integrator) part number, revision number, serial number, specification number, and purchase order number.
- b. Review and approval page of Subcontractor acceptability with signatures of an engineering representative, a configuration representative, a program manager, and a QA manager. This will be COC.
- c. ABCL, showing the as built revision of the Subcontractor's lowest detail drawing level of the End Item including the applicable serial number.
- d. User's manuals which contains operation constraints and handling precautions
- e. Nonconformances and changes section:
 - Nonconformance Status List. This list shall contain all of the minor and major nonconformance status.
 - Copies of all the Subcontractor's change proposals which classified as Class 1
 - Copies of all the Subcontractor's major nonconformance reports. These will include retest instructions.
 - Waivers and deviations requests
 - All applicable letters
- f. Inspection report according to the mechanical ICD. This report shall include measurement results.
- g. Contamination budget report. This report shall be prepared for contamination critical hardware.
- h. Acceptance test report which contains analysis and test results, including special engineering test, as applicable.
- i. Trend analysis report for the critical parameter
- j. Listing of test equipment used, including manufacturer, model number, serial number, and

date of last calibration

k. The level of contamination at the delivery for the contamination critical hardware

l. Cumulative logs for operating time or operating cycles, vibration time per axis, number of temperature and pressure cycles, number of switch actuations, and connector mate and demate cycles. This log summary shall be annotated with part number, serial number, and date

m. Photographic identification logs

G.8. CONFIGURATION CONTROL

Engineering, manufacturing, and tooling drawings and specifications are subject to a system of configuration control in accordance with Section 5 of this PAR.

The system shall ensure that only drawings, test procedures, and specifications of the latest applicable revision are available to operational personnel at the appropriate points during manufacturing, inspection, and testing. The system shall ensure the removal of obsolete documents from manufacturing, inspection, and test areas.

G.9. CONTAMINATION CONTROL

The Subcontractor shall have contamination control procedures for measuring and maintaining the required levels of cleanliness during the various phases of hardware assembly and testing.

Contamination control requirements are further detailed in Section 11 of this PAR.

G.10. CUSTOMER FURNISHED EQUIPMENT

The Subcontractor shall establish and maintain documented procedure for the control, verification, storage, and maintenance of CFE.

When CFE is furnished by Customer (Satellite System Integrator) , the Subcontractor shall inspect to detect damage in transit and provide for the protection, periodic inspection, and controls necessary to preclude damage or deterioration during handling, storage, or use.

The Subcontractor shall report to Customer (Satellite System Integrator) any parts which are damaged, malfunctioning, or otherwise unsuitable for use and shall determine and report the probable cause and necessity for withholding such CFE from use.

Unsuitable CFE shall be handled in such a manner as to prevent further damage and additional repair costs.

G.11. GROUND SUPPORT EQUIPMENT

The status of the MGSE, EGSE, and test aids used for manufacturing or testing the hardware

being procured shall be controlled by the Subcontractor's QA system.

Validation of equipment shall be carried out before use with the FM. This validation shall include a calibration status check, a maintenance status check, and a functional demonstration. Evidence of validation shall be available to Customer (Satellite System Integrator) upon request.

APPENDIX H. 신뢰성 (RELIABILITY)

H.1. GENERAL

The Subcontractor shall establish, implement, and maintain a reliability program plan as a part of Product Assurance Plan.

The product shall comply with the reliability requirements listed here:

- a. The product failure rate shall respect the reliability objective specified in the product technical requirement.
- b. The product shall respect the derating rules for EEE parts.
- c. All parts shall demonstrate compliance with space environment specification.
- d. The product shall provide provision for failure detection and switching off.
- e. The product shall avoid failure propagation in case of redundancy.
- f. The product shall respect the design safety factors.
- g. The product shall be designed to meet the lifetime specified in the technical specification.

In case hardware configuration is modified, related analysis and reports shall be updated and resubmitted to Customer (Satellite System Integrator).

H.2. RELIABILITY PREDICTION

A reliability prediction shall be performed under the actual environmental and stress condition.

For the high reliability parts which have appropriate quality level, MIL-HDBK-217F Notice 2 shall be used preferably as the failure rate database. If the parts are not covered by MIL-HDBK-217F Notice 2, failure rate investigation methods or its data source shall be agreed with Customer (Satellite System Integrator).

The reliability prediction report shall include functional schematics, parts reliability data, equipment reliability model, and any assumption used for the analysis.

H.3. FAILURE MODE, EFFECTS, AND CRITICALITY ANALYSIS

FMECA analysis procedures and documentation shall be performed in accordance with ECSS-Q-ST-30-02 or equivalent standards with the severity categories described in Table H.1 and H.2. The FMECA shall identify how each failure mode is detected and shall recommend counter-measures to render such consequences. FMECA shall be accompanied by FDIR process.

For the failure modes of redundancy interface circuit or the failure modes resulting in a severity of category 1, the failure mode shall be analyzed to the depth of parts level.

In case of a unit including software, the effects of software errors shall be assessed at the functional level.

Common-mode analyses shall be performed on reliability and safety critical items to identify the root cause of failures that have a potential to negate failure tolerance levels. This analysis shall be included in the FMECA.

An FTA shall be performed at system and subsystem level for specified top events when specifically requested.

Table H.1 Severity category definitions at equipment level

Severity Category	Definition
1	Failure mode causes damage by propagation to interfacing units
2	Failure mode causes the loss of required function
2R	Failure mode causes the loss of redundant function
3	Failure mode causes the degradation of the required function
4	Failure mode causes minor degradation
5	No effect

Table H.2 Severity category definitions at subsystem level

Severity	Category	Definitions
Catastrophic	1	Failure modes that could result in serious injury or loss of life or loss of launch vehicle
	1R	Failure modes of redundant hardware item that, if all failed, could result in Category 1 effects.
	1S	Failure in a safety or hazard monitoring system that could cause the system to fail to detect a hazardous condition or fail to operate during such condition and leads to Severity Category 1 consequences.
Critical	2	Failure modes that could result in loss of one or more mission objectives.
	2R	Failure modes of redundant hardware items that could result in Category 2 effects if all failed.
Significant	3	Failure modes that could cause degradation to mission objectives.
Minor	4	Failure modes that could result in insignificant effect to mission objectives.

H.4. PART STRESS ANALYSIS

The derating rules applied to EEE parts will limit the application conditions of voltage, current, power, temperature, mechanical environment, and duty cycle to achieve part failure rates consistent with reliability requirements.

ECSS-Q-ST-30-11, GSFC EEE-INST-002, or MIL-STD-975 shall be applied to the application of all EEE parts. In case other derating rules are used, justification for the rules shall be submitted to Customer (Satellite System Integrator) for approval.

All of the EEE parts shall be derated to establish derating levels, and analyses shall be performed to demonstrate that each part meets the stress derating criteria in each phase of the mission of the equipment in normal, transient and contingency operating modes.

The list of the parts exceeding the stress criteria with its respective parameters is presented in the Part Stress Analysis document. Areas of noncompliance shall be identified with proposed solutions or justifications for use.

Deviation from derating criteria shall be subjected as a RFD.

H.5. WORST CASE ANALYSIS

The Subcontractor shall provide an analysis of the effects on design performances as it is influenced by part parametric variations, environmental effects, radiation effects, input and output variations, part tolerance, aging, etc.

This analysis shall verify that within reasonable combinations of specification characteristics and parts tolerance, the design meets specified performance in worst mission period.

A final assessment report shall include the functions on which analysis has been performed, the supporting circuits, and compliance status.

H.6. TREND ANALYSIS

The critical parameters of the End Product that can be monitored during testing shall be identified at Design Reviews and trends shall be tracked during testing.

The analysis results shall be included in the EIDP. Items with unusual or abnormal trends shall be noticed to Customer (Satellite System Integrator).

H.7. CRITICAL ITEM LIST

Critical items shall be identified and maintained in a critical items list throughout the product's life cycle. An item shall be considered critical when:

- a. It is not a space qualified design or technology.
- b. It has safety hazards for hardware or personnel.
- c. Failure mode severity is assigned to category 1.
- d. The relevant failure rate is not justified.
- e. It is hardware which is sensitive to age or wear or requires special ground handling conditions. This will be a Limited Life Item.
- f. Parts are out of accepted derating conditions.
- g. Parts or materials are not qualified.

The critical item list document shall include the following information as a minimum:

- a. Item description
- b. Reason for criticality
- c. Risk mitigation plan

All reliability critical items shall be incorporated in the risk management system for the criticality mitigation process.

H.8. LIMITED LIFE ITEM

The End Product shall be designed considering operational life, storage life, and assembly, integration and test life.

All parts of the End Product being procured shall be reviewed for wear or degradation during its designed lifetime. Analytic or test data justification shall be developed showing that an adequate life margin exists.

Limited life items are hardware subject to degradation due to age, operating time, or cycles and thus require periodic replacement, refurbishment, retest, or operation to assure that its mission performance will not be degraded beyond acceptable limits. These items shall be identified in the Limited Life Item List with the accumulated time or cycle tracking and maintenance records.

If deliverable hardware requires maintenance activities during storage, assembly, and testing period, the Subcontractor shall describe appropriate maintenance activities in the user's manual and agree with Customer (Satellite System Integrator) before unit shipment.

APPENDIX I. 안전관리 (SAFETY)

I.1. GENERAL

The Subcontractor shall observe applicable safety laws or ordinances.

The Subcontractor shall implement a safety program that will ensure the identification and control of hazards during fabrication, testing, transportation, ground activities, and launch operations.

Hardware and software nonconformance that occur during the course of the verification program shall be reviewed for their safety implications.

I.2. HAZARDOUS OPERATIONS

The Subcontractor safety engineer shall identify all potentially hazardous operations in the Subcontractor's facilities.

When the operation could result in hazardous effect on the personnel, an investigation shall be performed to identify and adequately control the hazards.

A report of each investigation shall be available for review at the Subcontractor's facility.

I.3. COMPLIANCE TO SAFETY REQUIREMENTS

The Subcontractor shall demonstrate that the End Product is compliant with safety requirements of the applicable launch site range. The demonstration of safety compliance shall be accomplished by the appropriate analysis or test.

The Subcontractor shall submit a safety assessment report applicable to the phase of the program at the time of design review. The contents of the safety assessment report shall be consistent with the requirements of the applicable launch vehicle and launch site requirements.

The safety reports shall include, as a minimum, a description of the product design, safety requirement compliance status, hazard analysis or test results, and other applicable safety related information.

I.4. SUPPORT FOR SAFETY REVIEW

The Subcontractor shall provide technical support to Customer (Satellite System Integrator) for applicable safety reviews.

APPENDIX J. 자재/기계부품 및 공정 (MATERIAL, MECHANICAL PART AND PROCESS)

J.1. GENERAL

The Subcontractor is required to observe the requirements of this PAR. The Subcontractor is also fully responsible for selection, procurement, and application of the materials and processes. The Subcontractor shall provide a materials and processes plan as a section of PAPP or as a separate document. The document shall describe all activities implemented for conformance to program requirements.

J.2. MATERIALS SELECTION

Materials shall be selected with full consideration of the effects of the space environment and shall satisfy applicable requirements based on the criteria described herein.

Use of materials with a history of successful spacecraft applications and existing specifications and databases will minimize verification efforts.

Materials used in a conventional process with successful flight heritage and which meet the selection criteria within this PAR will be classified as compliant materials.

Noncompliant materials are any materials not defined as compliant. These will include the materials which meet the requirements but are not used in conventional applications.

Off-the-shelf hardware for which a detailed materials list is not available and where the included materials cannot be easily identified and/or changed shall be considered to be noncompliant.

Compliant materials shall be used in the fabrication of flight hardware to the maximum practical extent.

Noncompliant materials shall be deemed critical, as defined in Section J.8.1 of this PAR, and the Subcontractor shall prepare a RFA package, with adequate justification for its use, and submit it for review and approval to Customer (Satellite System Integrator)'s PMPCB.

J.2.1. Restricted Materials

Due to limited life, safety concerns, or known instability, the following materials are not recommended:

- a. Beryllium or selenium except internal to hermetically sealed devices.
- b. Unalloyed electrodeposited tin unless subsequently fused or reflowed.
- c. Corrosive solder fluxes unless detailed cleaning procedures are specified that include verification methods to ensure removal of residual contaminants.

- d. Teflon, vinyl, polyvinyl chloride used as an insulator for electrical harness wire. Fluorocarbon polyimide wire 'Kapton®' is to be controlled as a critical item.
- e. Materials which exhibit or are known to exhibit natural radioactivity such as uranium, potassium, radium, thorium or any alloys thereof.
- f. Indium and indium solder
- g. Magnesium
- h. Lithium

Where the use of any of these materials is unavoidable, the application shall be evaluated on a case-by-case basis and the Subcontractor shall prepare a RFA package, with adequate justification for its use, and submit it for review and approval to Customer (Satellite System Integrator)'s PMPCB.

J.2.2. Prohibited Materials

The use of pure mercury, cadmium, pure electrodeposited or hot dipped tin-plated surface coatings, zinc and PVC is prohibited.

These materials can be used in the way that unit design mitigates material instability. The Subcontractor shall prepare a RFA package, with adequate justification for its use, and submit it for review and approval to Customer (Satellite System Integrator)'s PMPCB.

J.3. MATERIALS REQUIREMENTS

J.3.1. Corrosion

Metallic materials selected for use in flight hardware shall be corrosion resistant or protected from corrosive environments by finishing and prevention of moisture condensation on corrosion susceptible hardware by environmental control or using seals and metallurgical joints.

Non-metallic parts shall not have a corrosion stimulating effect on other materials when exposed for their specific useful life.

Incompatible couples defined by MIL-STD-889 shall be avoided. Such dissimilar metals may be used in intimate contact, but only if the assembly is protected in a manner as to preclude moisture.

J.3.2. Stress Corrosion

Metals and alloys shall not have a propensity towards stress corrosion cracking, as defined in Table I of ECSS-Q-70-36A. Metals and alloys in Table II or III of ECSS-Q-70-36A may be used with Customer (Satellite System Integrator)'s PMPCB approval.

Metals and alloys that are susceptible to stress corrosion cracking shall be avoided in sustained tensile applications.

J.3.3. Hydrogen Embrittlement

Metals, particularly high strength steels and titanium alloy, which will be exposed to a hydrogen rich environment or subjected to processes that can introduce hydrogen in the metal, shall be evaluated for susceptibility to hydrogen embrittlement. Any resulting reduction in performance will be highlighted and appropriate measures will be taken to eliminate the effect.

J.3.4. Magnetism

The use of magnetic materials is not permitted, if it can be avoided, and shall be avoided as far as practicable to allow for a high degree of magnetic cleanliness for the spacecraft. All magnetic materials are to be identified in the materials list and a justification for their use shall be submitted for review and approval to Customer (Satellite System Integrator)'s PMPCB.

J.3.5. Fluid Compatibility

Metallic and nonmetallic materials that will be in contact with an identified fluid shall be compatible with that fluid. If compatibility data are not available, testing shall be performed according to NASA-STD-(I)-6001A test number 15.

Metallic materials directly exposed to propellants shall not exhibit surface corrosion.

J.3.6. Vacuum Stability

Only materials that have TML and CVCM less than the requirements in Section 11 shall be used in a vacuum environment.

J.3.7. Flammability

Major use organic materials for flight shall be nonflammable or self-extinguishing in air in the application configuration.

J.3.8. Radiation Sensitivity

Exterior and exposed materials shall be capable of functioning as intended in an orbital charged particle and UV radiation environment.

J.3.9. Electrostatic Discharge Protection

Materials used in areas sensitive to electrostatic discharge shall be selected to ensure that the

maximum potential difference between any two points on the spacecraft is within the limits of applicable ESD/EMC requirements.

J.4. MECHANICAL PARTS SELECTION

Mechanical parts shall be selected with full consideration of the effects of the space environment and shall be selected on the basis of previous space heritage in an identical application.

Mechanical parts which has successful flight heritage and will be procured to the ESA or MIL specification will be classified as standard part.

Nonstandard parts are any mechanical parts not defined as standard. These will include the standard parts used in alternative application.

Standard part shall be used in the flight hardware design to the maximum practical extent.

Where a mechanical part is not controlled by an ESA or MIL specification, current and fully configured specifications applicable to the relevant Subcontractor should be used to ensure full control over the procurement and performance of the mechanical part.

All materials that comprise a mechanical part must be individually assessed in accordance with the requirements of this document and listed on the Materials Identification List.

Nonstandard parts shall be deemed critical, as defined in Section J.8.1 of this PAR, and the Subcontractor shall prepare a RFA package, with adequate justification for its use, and submit it for review and approval to Customer (Satellite System Integrator)'s PMPCB.

J.5. PROCESS SELECTION

All manufacturing and assembly processes used shall be carefully selected so that material integrity is maintained and physical property changes are well understood and controlled.

Processes which has successful flight heritage with the use of compliant materials will be classified as conventional process.

Nonconventional processes are any processes not defined as conventional. For the nonconventional processes, process verification is required.

Conventional processes shall be used in the fabrication of flight hardware to the maximum practical extent.

If a nonconventional process is applied, the Subcontractor shall verify for the desired process application on the basis of tests, similarity, analyses, inspection, existing data, or a combination of those methods.

Nonconventional process shall be deemed critical, as defined in Section J.8.1 of this PAR, and the Subcontractor shall prepare a RFA package, with adequate justification for its use, and

submit it for review and approval to Customer (Satellite System Integrator)'s PMPCB.

J.6. SPECIFIC REQUIREMENTS

J.6.1. Pyrotechnic Parts

The selection, procurement and application of pyrotechnic devices shall conform to the requirements of ECSS-E-30 Part 6A. All devices selected for use must be subject to the qualification, acceptance and verification testing of this specification.

Primary and redundant devices must not be taken and installed from the same lot.

The pyrotechnic device subsystem must be subject to an end-to-end test prior to launch.

J.6.2. Shelf Life Materials

Materials with limited lifetime characteristics shall be subject to lot/batch acceptance tests, and shall have the date of manufacture and shelf-life expiration date marked on each lot/batch.

Storage conditions must be controlled to avoid degradation of the material. Storage conditions and shelf life should be stated in the procurement specification.

The material whose shelf life has expired shall be segregated from other conforming materials and shall not be used on the FM fabrication unless the material is validated by means of appropriate tests.

J.7. PROCUREMENT

The Subcontractor shall describe the procurement methods.

The procurement of materials shall be done by formal procurement document. These procurement documents shall be approved by the Subcontractor's MPCB.

J.8. MATERIALS AND PROCESS APPROVAL

J.8.1. Critical Materials and Processes

For the materials, mechanical parts, and processes identified as critical, the Subcontractor shall prepare a RFA package, with adequate justification for its use, and submit it for review and approval to Customer (Satellite System Integrator)'s PMPCB.

The definition of a critical material, mechanical part or process is as followings:

a. Materials

- It is new, has no previous space use or is non-validated, in the application in question.
- Previous use has highlighted technical issues.

b. Mechanical parts

- It is new, has no previous space use or is non-qualified, in the application in question.
- Previous use has highlighted technical issues.
- Failure of the mechanical part can adversely affect the performance or destroy a major part or function of the spacecraft.
- The quality of the mechanical part cannot be assessed by simple tests.

c. Processes

- It is new, has no previous space use or is non-validated, in the application in question.
- Previous use has highlighted technical issues.
- Failure of the process can adversely affect the performance or destroy a major part or function of the spacecraft.
- The Subcontractor has no prior application experience.
- The quality of the process cannot be assessed by examining the End Product.

All critical materials, mechanical parts, and processes shall be evaluated and qualified. The qualification reports are to be approved by Customer (Satellite System Integrator). The qualification of all critical materials, mechanical parts or processes shall be completed and accepted by Customer (Satellite System Integrator) before the materials, mechanical parts or processes are used on FM hardware.

RFA shall include all the contents defined in APPENDIX C.

J.8.2. Material and Process Control Board

The selection, application, and approval of materials and process shall be implemented through the Subcontractor's MPCB.

The major activities of the Subcontractor's MPCB are listed below:

- a. Review and approve process specification, materials specification, and procurement document.
- b. Prepare verification plans for nonconventional processes.
- c. Investigate materials and process related issues during the entire program life cycle.
- d. Prepare material identification lists and process lists and submit them to Customer (Satellite System Integrator).
- e. Prepare RFA documents and submit them to Customer (Satellite System Integrator)'s PMPCB for approval.

J.9. MATERIALS, MECHANICAL PARTS AND PROCESSES LIST

The Subcontractor shall prepare a list of materials, mechanical parts, and processes identified

in this program.

The lists shall cover all materials and processes used in the equipment, including those used at lower tier Subcontractors level and all materials, mechanical parts and processes used during the AIT phase.

The lists shall include all the contents defined in APPENDIX C.

J.10. SPECIFICATION

All of the materials and mechanical parts shall be procured in accordance with the standard specification or customized specification designated for the material.

All of the Subcontractor's processes shall be recorded and maintained in the form of process specifications.

The specification shall contain all necessary physical, environmental, performance, and qualification requirements.

Specification for the noncompliant materials and/or nonstandard parts shall be submitted with the RFA document.

The process specifications shall be available to Customer (Satellite System Integrator) at the Subcontractor's facilities.

J.11. RECEIVING INSPECTION

Each material shall be submitted to a receiving inspection. The objective of the inspection is to verify the compliance with the procurement specifications and the purchase order requirements. Receiving inspections shall at least include data review and visual inspection. Characterization tests shall be performed if required.

J.12. TRACEABILITY

The Subcontractor shall ensure that it is possible to reconstitute the material or part's history, either individually or by the manufacturing lot.

The Subcontractor shall ensure that the full traceability of materials and parts is maintained and recorded throughout the mission life of the End Product.

J.13. PROPRIETARY INFORMATION

Where materials, mechanical parts, or processes are considered proprietary by the Subcontractor and/or Supplier, Customer (Satellite System Integrator) will respect the right of the third party to withhold certain details. However sufficient information must be made available to Customer (Satellite System Integrator) to allow a full evaluation of the material, mechanical

part, or process with respect to the mission environment and lifetime requirements and to allow a full risk assessment to be carried out. The level of information exchange will be defined on a case-by-case basis dependent on the sensitivity of the requested information.

APPENDIX K. 전기전자부품 (EEE PARTS)

K.1. GENERAL

EEE parts for qualification models shall be from the same design type (Form, Fit, Function) and manufacturer as the ones intended to be used on FMs.

The Subcontractor shall ensure that all parts requirements are flowed-down to all his Subcontractors and ensure that all his Subcontractors are compliant to these parts requirements.

K.2. PARTS SELECTION

The Subcontractor shall ensure that the selected parts meet the operating, environmental, radiation, material, safety, quality and reliability conditions defined for the program.

[QUALITY REQUIREMENT FOR EEE PARTS FOR GEO]

EEE parts listed in the EPPL part I, ESCC QPL parts, NPSL level 1 parts (with disposition of the associated application note), GSFC EEE-INST-002 level 1 parts (with disposition of the associated application note), and MIL QPL/QML parts (a quality level is based on the NPSL level 1) shall be used as the primary basis for parts selection.

[QUALITY REQUIREMENT FOR EEE PARTS FOR LEO]

EEE parts listed in the EPPL part I and II, ESCC QPL parts, NPSL level 1 and 2 parts (the associated application note shall apply), GSFC EEE-INST-002 level 1 and 2 parts (the associated application note shall apply), and MIL QPL/QML parts (a quality level is based on the NPSL level 1 or 2) shall be used as the primary basis for standard parts selection.

EEE parts which satisfy the screening requirement of Section K.3 and APPENDIX K will be classified as program standard parts. Nonstandard parts are any parts not defined as standard parts.

Standard parts shall be used in the flight hardware design to the maximum practical extent. When equipment development and qualification conditions or technical issues do not allow use of the above standard level, the next available level in the above ESCC or US MIL systems shall be considered.

In the case that a valid and acceptable status cannot be demonstrated, an adequate evaluation program shall be implemented to comply with the requirements specified for the program.

If nonstandard parts are used in the flight hardware, the Subcontractor shall prepare a PAD

package, with adequate justification for its use and supplementary test, and submit it for review and approval to Customer (Satellite System Integrator)'s PMPCB.

K.2.1. Radiation Hardness

All the parts used in the end product shall be selected to meet their mission application for the specified, predicted radiation environment. These requirements are established for all kinds of radiation including cosmic, trapped and solar flares.

The Subcontractor shall implement radiation hardness assurance programs which assess actual radiation tolerance of the selected components for compliance with the KOMPSAT or GEOKOMPSAT radiation requirements in term of Total Dose, displacement damages, and single events effects.

The Subcontractor shall issue a radiation assessment report identifying all sensitive components with respect to the relevant radiation effects, their impact and giving an adequate design solution for the equipment. The radiation assessment report shall be submitted to Customer (Satellite System Integrator).

- a. Total Ionizing Dose (TID) : In order to reduce the Total Dose risk, parts can be shielded or replaced. Any other solutions may be used as appropriate.
 - $2 \times \text{Received Dose Level} < \text{TID Sensitivity of the parts}$: FM lot is accepted as is.
 - $1.3 \times \text{Received Dose Level} < \text{TID Sensitivity of the parts} < 2 \times \text{Received Dose Level}$: Radiation lot acceptance test is required. If FM lot parametric and functional hardness is larger than 1.3 times the dose level, the FM lot is accepted.
 - $\text{TID Sensitivity of the parts} < 1.3 \times \text{Received Dose Level}$: The part is not acceptable as is. Shielding of parts, replacement, or any other solutions shall be found.
- b. Displacement Damage: In order to reduce the displacement damage risk, parts can be shielded or replaced. Any other solutions may be used as appropriate.
 - $2 \times \text{Received DDEF Level} < \text{DDSF of the parts}$: FM lot is accepted as is.
 - $1.3 \times \text{Received DDEF Level} < \text{DDSF of the parts} < 2 \times \text{Received DDEF Level}$: Radiation lot acceptance test are required. If FM lot parametric and functional hardness is larger than 1.3 times the DDSF level, the FM lot is accepted.
 - $\text{DDSF of the parts} < 1.3 \times \text{Received DDEF Level}$: The part is not acceptable as is. Shielding of parts, replacement, or any other solutions shall be found.
- c. Single Event Phenomenon (SEP) : Evaluation of SEP shall be performed according to the following criteria. LETth(SEP) means threshold LET for a specific kind of SEP. The source of part radiation data will be considered when evaluation of SEP.

- $60 \text{ MeV}\cdot\text{cm}^2/\text{mg} < \text{LET}_{\text{th}}(\text{SEP})$: Part is considered as not sensitive to the specific SEP. FM lot is accepted as is.
- $15 \text{ MeV}\cdot\text{cm}^2/\text{mg} < \text{LET}_{\text{th}}(\text{SEP}) < 60 \text{ MeV}\cdot\text{cm}^2/\text{mg}$: Part is sensitive to heavy ion induced SEP but not sensitive to proton induced SEP. Heavy ion induced SEP rate and their effects shall be analyzed to identify the effects and criticality. Risk reduction actions required if the mitigation is necessary from the analysis. Final decision will be taken at Customer PMPCB.
- $\text{LET}_{\text{th}}(\text{SEP}) < 15 \text{ MeV}\cdot\text{cm}^2/\text{mg}$: Part is sensitive to heavy ion and proton induced SEP. Heavy ion and proton induced SEP rate and their effects shall be analyzed to identify the effects and criticality. Risk reduction actions required if the mitigation is necessary from the analysis.

The use of part, which is not acceptable as is, shall be reviewed and approved by Customer PMPCB.

K.2.2. Restricted Parts

The Subcontractor shall ensure that materials which are not hermetically sealed within components meet the requirements of Section 10 regarding outgassing, flammability, toxicity, and criteria required for the intended use.

The Subcontractor shall insure that EEE part does not contain health and safety hazard materials such as beryllium oxide, cadmium, lithium, magnesium, mercury, or radioactive material.

The Subcontractor shall also evaluate the robustness of selected EEE components to the stresses induced during assembly process.

For limited life, known instability, safety hazard or reliability risk reasons, the use of EEE parts listed below shall be prohibited:

- a. Component using pure tin material plating
- b. Hollow core resistors
- c. Potentiometers (except for mechanism position monitoring)
- d. Non-metallurgically bonded diodes
- e. Semiconductor dice without passivation or glassivation over exposed active area
- f. Wet slug tantalum capacitors other than capacitor construction using double seals and a tantalum case
- g. TO5 relays without double welding of the mechanism to the header or with any type of integrated diodes inside
- h. Wire-link fuses $< 5\text{A}$
- i. RNC90 resistors above $100 \text{ k}\Omega$ (for new design)

- j. TO3 and DO4/DO5 packages (for new design)

K.3. PROCUREMENT

The Subcontractor shall describe the procurement scheme in the parts control plan.

The procurement of materials shall be done by formal procurement document. These procurement documents shall be controlled by Subcontractor's responsibility.

To reduce the risk of procuring counterfeit parts, when parts are not directly procured from the manufacturer, the supplier shall procure parts only from distributors duly franchised by the parts manufacturer.

K.3.1. Quality Level

All EEE parts to be incorporated into flight hardware shall be subjected to screening tests. These screening tests shall be designed so that accumulated stress will not jeopardize the part reliability.

The baseline of quality level used to procure or to up-screen EEE parts is described in APPENDIX K.10

K.3.2. Procurement Specification

Any EEE part intended for use in flight hardware shall be procured to controlled specifications.

International specifications systems such as ESCC or MIL, recognized as suitable for space applications, shall be used by the Subcontractor.

This document shall be configuration controlled by the Subcontractor, and submitted to Customer (Satellite System Integrator) PMPCB for approval through the PAD process.

The EEE parts procurement responsible is requested to ask the manufacturer to give notification of any product change affecting qualification, performance, quality, reliability and interchangeability and to communicate this information to the Subcontractor (if applicable).

The issue and revision of the detail procurement specifications shall be specified in the Part Identification List.

K.3.3. Lot Acceptance Test and Quality Conformance Inspection

Any lot of EEE parts shall be submitted to a LAT (ESCC system) or QCI/TCI (MIL system) procedure according to the following rules:

- a. ESA qualified parts : For ESA qualified parts, LAT is implemented in accordance with the ESA specifications.
- b. MIL qualified parts : For MIL qualified parts, QCI/TCI is implemented in accordance with the

quality level of the MIL specification.

- c. Non-qualified parts : For non-qualified parts purchased to source control drawing, LAT or QCI shall be performed in accordance with the closest applicable ESA or MIL specification. The content of the lot acceptance is ESCC level LAT1 or level LAT2 or LVT(subgroups 1, 2, and 3) or comparable QCI. Customer (Satellite System Integrator) will approve the proposed level during PMPCB, through the PAD provided by the Subcontractor.

When a lot built with different sub lots is submitted to LAT/QCI, the distribution of these sub lots shall be identified and the LAT/QCI sampling shall be representative of this distribution.

A failure analysis shall be performed on any part which failed during the LAT/QCI/TCI. Analysis result shall be available for review by Customer (Satellite System Integrator), on request.

EEE parts used during life test of LAT/QCI /TCI are prohibited to be used as flight parts.

K.3.4. Destructive Physical Analysis

The DPA shall be performed on 3 samples per lot for nonstandard parts belonging to the following categories:

- a. Hybrid circuits,
- b. Microcircuits,
- c. Discrete semiconductors,
- d. Relays and switches,
- e. Crystals and Oscillators,
- f. Passive microwave devices,
- g. Capacitors (ceramic, tantalum, and variable),
- h. Filters

Either standard or not, the DPA shall be performed on 3 samples per lot on relays, oscillators, and hybrids. The DPA sample size may be reduced in some cases which shall be submitted to Customer (Satellite System Integrator) for approval through the PAD process.

The Subcontractor shall verify that the outcome of the DPA is satisfactory prior to the installation of the components into flight hardware.

The DPA procedure and reports, which includes photos, shall be provided to Customer (Satellite System Integrator) for review on request.

K.3.5. Radiation Hardness Verification

Radiation sensitive parts, as defined in K.2.1, and for which applicable existing test data is insufficient shall be subjected to RVT.

RVT shall be performed in accordance with internationally recognized standards, such as ESCC

Basic Specifications No. 22900 and No 25100, MIL-STD-750 Test Method 1080, MIL-STD-883 Test Method 1019, or JEDEC JESD57.

The results of RVT shall be documented by a report and shall be provided to Customer (Satellite System Integrator) for review on request.

K.4. SPECIFIC PARTS REQUIREMENTS

K.4.1. Application Specific Integrated Circuits (ASIC)

ECSS-Q-ST-60-02 or equivalent MIL specification shall apply for the design development of ASICs.

K.4.2. One Time Programmable Devices

For FPGA, ECSS-Q-ST-60-02 or equivalent MIL specification, shall apply for the design development. The Subcontractor shall submit a post-programming procedure, depending on part types (including, when necessary, electrical tests, programming conditions and equipment, burn-in conditions, additional screening tests and specific marking after programming) to Customer (Satellite System Integrator) for approval.

K.4.3. Hybrids Devices

The Subcontractor shall manufacture Hybrids in accordance with the requirements of MIL-PRF-38534 Class K or ECSS-Q-ST-60-05 shall apply.

K.4.4. Electromagnetic Devices

The in-house magnetic parts shall be designed and screened using MIL-STD-981 as a guide line.

K.4.5. Microwave Monolithic Integrated Circuits

ECSS-Q-ST-60-12 or equivalent MIL specification shall be applied.

K.5. PARTS EVALUATION PROGRAM

The Subcontractor shall implement a part evaluation and approval testing program in absence of an approved demonstration that a part has the ability to conform to the requirements for performance, quality, reliability, and environmental resistance as required for the program.

The evaluation program, documented by an evaluation plan, shall identify the manufacturing baseline in order to ensure that the flight parts shall be built according to the same technology

and manufacturing processes as the evaluated components.

In the case that a change affects the qualification status, a new qualification or a delta qualification shall be undertaken.

For commercial parts, the Subcontractor is encouraged to perform a single procurement for evaluation and flight parts in order to ensure that the evaluation results are representative of the flight parts.

The evaluation plan is based on the following elements:

- a. Constructional analysis
- b. Manufacturer assessment
- c. Evaluation testing (according to the Qualification or LAT/QCI of the ESCC/MIL standard parts depending on the part consideration)
- d. Radiation testing (if applicable, depending on the component sensitivity and the program requirements)

Reduction or omission of any element of the evaluation requirements shall be justified on the basis of documentary evidence provided by the responsible of the evaluation program.

The evaluation plan shall be submitted to Customer (Satellite System Integrator) for approval, in the frame of PAD process. The evaluation results, documented by an evaluation report, shall be submitted to Customer (Satellite System Integrator) for approval.

The preliminary PAD approval does not prejudice its final acceptance. The final approval shall be definitely pronounced when the evaluation is successfully completed.

Failure analysis shall be conducted on any part which failed during this evaluation program, in order to determine the reason for failure and to react at procurement level or at part selection level.

K.6. PART IDENTIFICATION LIST

The Subcontractor shall issue a Part Identification List, identifying all EEE parts used for each unit. The Subcontractor Part Identification List shall include Lower Tier Subcontractor's or Supplier's Part Identification List. The subcontractor shall issue the Part Identification List and the As-built Part Identification List in editable and sortable electronic format.

K.7. RECEIVING INSPECTION

Each part shall be submitted to an incoming inspection. The objective of the inspection is to verify the compliance with the procurement specification and the purchase order requirements.

The receiving inspection shall at least include following verifications:

- a. Compliance with the purchase order requirements

- b. Manufacturer Certificate of Conformance (COC)
- c. Integrity of the parts by visual inspection
- d. Packaging of the components
- e. Review of delivered documentations
- f. Quantity

K.8. HANDLING AND STORAGE

The Subcontractor shall establish and implement procedures for handling and storage of EEE parts in order to prevent any degradation, taking into account the possible use of plastic packages.

As a minimum the following areas shall be covered:

- a. Control of storage environment such as temperature ($22\pm 5^{\circ}\text{C}$), humidity ($45\% < \text{RH} < 65\%$ max), cleanliness
- b. Appropriate measures and facilities for segregating and protecting parts during incoming inspection, storage and delivery to manufacturing
- c. Control measures to ensure that parts susceptible to ESD are identified and handled only by properly trained personnel using antistatic packaging, tools and other means, including procedures

For PEM Devices, specific requirements for handling, storage, and bake-out before mounting shall be applied.

K.9. NONCONFORMANCE

Any observed deviation of EEE parts from requirements of applicable specifications, procedures and drawings shall be controlled by the nonconformance control system.

The nonconformance control system shall handle all nonconformances occurring on EEE parts during:

- a. Manufacturing (if available), screening and acceptance tests,
- b. Incoming inspection,
- c. Integration and test of equipment,
- d. Storage and handling.

K.10. QUALITY REQUIREMENT

TABLE K-1. QUALITY REQUIREMENT FOR EEE PARTS FOR LEO

Category	Quality Requirement		
Cables & wires, low frequency	ESCC	ESCC 3901 level B	
	MIL	MIL-W-22759 MIL-DTL-16878	
	Other	NEMA-WC27500	
Cables, coaxial, radio frequency	ESCC	ESCC 3902 level B	
	MIL	MIL-C-17	
	Other	-	
Capacitors, chip, ceramic	ESCC	ESCC 3009 level C	(Note 1)
	MIL	MIL-PRF-55681 EFRL R min MIL-PRF-123	
	Other	-	
Capacitors, molded, ceramic	ESCC	ESCC 3001 level C	(Note 1)
	MIL	MIL-PRF-20 EFRL R min MIL-PRF-39014 EFRL R min MIL-PRF-123 MIL-PRF-49470 EFRL T	
	Other	-	
Capacitors, glass (CYR type)	ESCC	ESCC 3004 level C	Not recommended for new design
	MIL	MIL-PRF-23269 EFRL R min	
	Other	-	
Capacitors, mica	ESCC	ESCC 3007 level C	
	MIL	MIL-PRF-39001 EFRL R min	
	Other	-	
Capacitors, chip, solid tantalum (TAJ, T495, CWR11, ...)	ESCC	ESCC 3011 level C ESCC 3012 level C	All capacitors shall be surge current tested.
	MIL	MIL-PRF-55365 WFRL C min	
	Other	-	
Capacitors, non-solid tantalum, electrolytic (CLR 79)	ESCC	ESCC 3003 level C	39006 / 22, 25, 30, 31 and "H" designated devices are recommended
	MIL	MIL-PRF-39006 EFRL R min	
	Other	-	
Capacitors, solid tantalum, electrolytic (CSR type)	ESCC	ESCC 3002 level C	Surge current test mandatory on low ESR capacitors (CSR21 and CSR33)
	MIL	MIL-PRF-39003 WFRL C min	
	Other	-	
Capacitors, super metallized plastic film, (CRH type)	ESCC	ESCC 3006 level C	
	MIL	MIL-PRF-83421 EFRL R min	
	Other	-	

Category	Quality Requirement		
Capacitors, super metallized plastic film, (CHS type)	ESCC	ESCC 3006 level C	
	MIL	MIL-PRF-87217	
	Other	-	
Capacitors, variable	ESCC	ESCC 3010 level C	Not recommended for new design
	MIL	-	
	Other	-	
Connectors, circular and rectangular, non-filter contacts	ESCC	ESCC 3401 level B	Outgassing control such as vacuum bake out is required for military circular connectors for contamination critical application.
	MIL	MIL-DTL-24308 (rect.) class M or K MIL-DTL-38999 (circ.) class G or H	
	Other	GSFC S-311-P-4, P-10(rect,)	
Connectors, circular and rectangular, filter contacts	ESCC	ESCC 3405 level B	Life test 1000H/125°C /1.5 V _r is mandatory on each tubular ceramic lot.
	MIL	-	
	Other	-	
Connectors, Printed Circuit Board	ESCC	ESCC 3401 level B	
	MIL	-	
	Other	-	
Connectors, Microminiature rectangular	ESCC	ESCC 3401 level B	
	MIL	MIL-DTL-83513	
	Other	-	
Connectors, RF coaxial	ESCC	ESCC 3402 level B	Outgassing control such as vacuum bake out is required for military parts for contamination critical application.
	MIL	MIL-PRF-39012	
	Other	-	
Crystals resonators	ESCC	ESCC 3501 level B	Crystal shall be built using a cultured premium Q swept material.
	MIL	MIL-PRF-3098	
	Other	-	
Diodes, low frequency	ESCC	ESCC 5000 level B	PIND test (Note 2,3)
	MIL	MIL-PRF-19500, JANTXV	
	Other	-	
Diodes, high frequency	ESCC	ESCC 5010 level B	PIND test (Note 2,3)
	MIL	MIL-PRF-19500, JANTXV	
	Other	-	
Filters, EMI	ESCC	ESCC 3008 level C	
	MIL	MIL-PRF-28861, class S	
	Other	-	
Fuses CERMET	ESCC	-	
	MIL	MIL-PRF-23419	
	Other	-	

Category	Quality Requirement		
Fuses (wire link $\geq$ 5A)	ESCC	-	Burn-in(168H / 85°C / 50% rated current) is mandatory on each lot. Specific derating shall be applied.
	MIL	MIL-PRF-23419	
	Other	-	
Heaters	ESCC	ESCC 4009 level C	
	MIL	-	
	Other	GSFC S-311-P-079	
Procured inductors, molded & chip	ESCC	ESCC 3201 level C	
	MIL	MIL-PRF-39010 EFRL R min MIL-STD-981 class S	
	Other	-	
Inductors & Coils, non-molded	ESCC	ESCC 3201 level C	
	MIL	MIL-STD-981 class S	
	Other	-	
Procured transformers	ESCC	ESCC 3201 level C	
	MIL	MIL-PRF-39010 EFRL R min MIL-STD-981 class S	
	Other	-	
Integrated circuits	ESCC	ESCC 9000 level B	PIND test (Note 2,3) FPGA (Note 4)
	MIL	MIL-PRF-38535, class Q	
	Other	-	
Integrated circuits Microwave (MMIC)	ESCC	ESCC 9010 level B	PIND test (Note 2,3)
	MIL	MIL-PRF-38535, class Q	
	Other	-	
Microwave passive parts (circulators, isolators)	ESCC	ESCC 3202 level B	
	MIL	-	
	Other	-	
Microwave passive parts (coupler, power dividers)	ESCC	ESCC 3404 level B	
	MIL	MIL-DTL-23971, "space flight"	
	Other	-	
Microwave passive parts (attenuators, loads)	ESCC	ESCC 3403 level C	
	MIL	MIL-PRF-39030 (loads) S letter (screened parts) MIL-DTL-3933 (attenuators) S letter (screened parts)	
	Other	-	
Oscillators (hybrids)	ESCC	ECSS Q-ST-60-05 Level 1	Lot sample DPA required (Note 3)
	MIL	MIL-PRF-55310 (class 2) level S	
	Other	-	

Category	Quality Requirement		
Resistors, fixed, film (RNC, RLR or MBx xxxx type, except RNC90)	ESCC	ESCC 4001 level C	
	MIL	MIL-PRF-55182 EFRL R min MIL-PRF-39017 EFRL R min	
	Other	-	
Resistors, high precision, fixed, metal foil (RNC90)	ESCC	ESCC 4001 level C-	100 KΩ max allowed. (Values above 100 KΩ are restricted for space flight use)
	MIL	MIL-PRF-55182/9 EFRL R min	
	Other	-	
Resistors, network, thick film	ESCC	ESCC 4005 level C	Lot sample DPA is required prior to use. Particulate attention should be paid to the integrity of the termination attachment to the resistive element (i.e., cracked solder joints, misaligned connections, etc.)
	MIL	MIL-PRF-83401 M part number level	
	Other	-	
Resistors, current sensing (RLV type)	ESCC	-	
	MIL	MIL-PRF-49465	
	Other	-	
Resistors, power, fixed, wirewound (RWR type)	ESCC	ESCC 4002 level C	
	MIL	MIL-PRF-39007 EFRL R min	
	Other	-	
Resistors, power, fixed, wirewound, chassis mounted (RER type)	ESCC	ESCC 4003 level C	
	MIL	MIL-PRF-39009 EFRL R min	
	Other	-	
Resistors, precision, fixed, wirewound (RBR type)	ESCC	-	Diameter of wires shall be greater than 0.03mm.
	MIL	MIL-PRF-39005 EFRL R min	
	Other	-	
Resistors, fixed, film, high voltage (RHV type)	ESCC	ESCC 4001 level C	
	MIL	-	
	Other	-	
Resistors, fixed, thick and thin film chip	ESCC	ESCC 4001 level C	
	MIL	MIL-PRF-55342 EFRL R min	
	Other	-	
Relays, electromagnetic, latching and non-latching	ESCC	ESCC 3601, level B ESCC 3602, level B	Products based on MIL-PRF-39016 are allowed with ESCC screening. Lot sample DPA required (Note 3)
	MIL	MIL-PRF-39016 EFRL R min + ESCC screening according to chart 3	
	Other	-	

Category	Quality Requirement		
Solar cells	ESCC	PSS-01-604	
	MIL	-	
	Other	-	
Switches, thermostatic	ESCC	ESCC 3702 level B	
	MIL		
	Other	GSFC S-311-641	
Switches, non RF	ESCC	ESCC 3701 level B	
	MIL	MIL-PRF-8805	
	Other	-	
Thermistors	ESCC	ESCC 4006 level B	
	MIL	MIL-PRF-23648	
	Other	GSFC S-311-P-018	
Transistors, low frequency	ESCC	ESCC 5000 level B	PIND test (Note 2,3)
	MIL	MIL-PRF-19500, JANTXV	
	Other	-	
Transistors, High frequency, (bipolar and GaAs)	ESCC	ESCC 5010 level B	PIND test (Note 2,3)
	MIL	MIL-PRF-19500, JANTXV	
	Other	-	
Opto-couplers, Opto-discrete devices	ESCC	ESCC 5000 level B	PIND test (Note 2,3)
	MIL	MIL-PRF-19500, JANTXV	
	Other	-	
Hybrids	ESCC	ECSS-Q-ST-60-05 level 2	Lot sample DPA required (Note 3)
	MIL	MIL-PRF-38534 class K	
	Other	-	
Surface Acoustic Waves (SAW)	ESCC	ESCC 3502 level C	
	MIL	MIL-PRF-38534 class K	
	Other	-	
Charge Coupled Devices (CCD)	ESCC	ESCC 9020 level B	
	MIL	-	
	Other	-	

Note 1 : For ceramic capacitors procured through ESA or MIL specifications but in an extended, non-qualified, range of value or not belonging to ESA QPL or MIL QML/QPL, the humidity, steady state, low voltage test (c.f. ESCC 3009, § 5.2.2) is mandatory if $U \leq 50V$ and $C \geq 1\mu F$.

Note 2 : Particle Induced Noise Detection (PIND) test is applicable to all cavity packages of active components, except non-metal packaged diodes.

- For semiconductor devices the JANS criteria is applicable per MIL-PRF-19500 : The lot shall be submitted to 100% PIND testing according to test condition A (per method 2052 of MIL-STD-750).

- For integrated circuits the Class level V criteria is applicable per MIL-PRF-38535 :
The lot shall be submitted to 100% PIND testing according to test condition A (per method 2020 of MIL-STD-883).

Note 3 : Additional DPA and PIND test need not be performed for Level 1 devices (ESCC (level B), JANS, and Class V, S, K)

Note 4 : Antifuse-based FPGA shall be used for design. If flash memory or SRAM-based FPGA will be used for design, PAD shall be submitted to KARI PMPCB for approval including radiation risk reduction actions such as EDAC and TMR.

TABLE K-2. QUALITY REQUIREMENT FOR EEE PARTS FOR GEO

Category	Quality Requirement		
Capacitors, super metallized plastic film, (CHS type)	ESCC	ESCC 3006 level C	
	MIL	MIL-PRF-87217	
	Other	-	
Capacitors, variable	ESCC	ESCC 3010 level C	Not recommended for new design
	MIL	-	
	Other	-	
Connectors, circular and rectangular, non-filter contacts	ESCC	ESCC 3401 level B	Outgassing control such as vacuum bake out is required for military circular connectors for contamination critical application.
	MIL	MIL-DTL-24308 (rect.) class M or K MIL-DTL-38999 (circ.) class G or H	
	Other	GSFC S-311-P-4, P-10(rect.)	
Connectors, circular and rectangular, filter contacts	ESCC	ESCC 3405 level B	Life test 1000H/125°C /1.5 V _r is mandatory on each tubular ceramic lot.
	MIL	-	
	Other	-	
Connectors, Printed Circuit Board	ESCC	ESCC 3401 level B	
	MIL	-	
	Other	-	
Connectors, Microminiature rectangular	ESCC	ESCC 3401 level B	
	MIL	-	
	Other	-	
Connectors, RF coaxial	ESCC	ESCC 3402 level B	Outgassing control such as vacuum bake out is required for military parts for contamination critical application.
	MIL	MIL-PRF-39012	
	Other	-	
Crystals resonators	ESCC	ESCC 3501 level B	Crystal shall be built using a cultured premium Q swept material.
	MIL	MIL-PRF-3098	
	Other	-	
Diodes, low frequency	ESCC	ESCC 5000 level B	PIND test (Note 2)
	MIL	MIL-PRF-19500, JANS	
	Other	-	
Diodes, high frequency	ESCC	ESCC 5010 level B	PIND test (Note 2)
	MIL	MIL-PRF-19500, JANS	
	Other	-	
Filters, EMI	ESCC	ESCC 3008 level B	
	MIL	MIL-PRF-28861, class S	
	Other	-	
Fuses CERMET	ESCC	-	
	MIL	MIL-PRF-23419	
	Other	-	

Category	Quality Requirement		
Cables & wires, low frequency	ESCC	ESCC 3901 level B	
	MIL	MIL-W-22759	
	Other	NEMA-WC27500	
Cables, coaxial, radio frequency	ESCC	ESCC 3902 level B	
	MIL	MIL-C-17	
	Other	-	
Capacitors, chip, ceramic	ESCC	ESCC 3009 level C	(Note 1)
	MIL	MIL-PRF-55681 EFRL R min MIL-PRF-123	
	Other	-	
Capacitors, molded, ceramic	ESCC	ESCC 3001 level C	(Note 1)
	MIL	MIL-PRF-20 EFRL R min MIL-PRF-39014 EFRL R min MIL-PRF-123 MIL-PRF-49470 EFRL T	
	Other	-	
Capacitors, glass (CYR type)	ESCC	ESCC 3004 level C	Life test 1000H/125°C /1.5V _r is mandatory on each lot. (Not recommended for new design)
	MIL	MIL-PRF-23269 EFRL R min	
	Other	-	
Capacitors, mica	ESCC	ESCC 3007 level C	
	MIL	MIL-PRF-39001 EFRL R min	
	Other	-	
Capacitors, chip, tantalum (TAJ, T495, CWR11, ...)	ESCC	ESCC 3011 level C ESCC 3012 level C	All capacitors shall be surge current tested.
	MIL	MIL-PRF-55365 WFRL C min	
	Other	-	
Capacitors, non-solid tantalum, electrolytic (CLR 79)	ESCC	ESCC 3003 level C	
	MIL	MIL-PRF-39006 EFRL R min	
	Other	-	
Capacitors, solid tantalum, electrolytic (CSR type)	ESCC	ESCC 3002 level C	Surge current test mandatory on low ESR capacitors (CSR21 and CSR33)
	MIL	MIL-PRF-39003 WFRL C min	
	Other	-	
Capacitors, super metallized plastic film, (CRH type)	ESCC	ESCC 3006 level C	
	MIL	MIL-PRF-83421 EFRL R min	
	Other	-	

Category	Quality Requirement		
Fuses (wire link $\geq 5A$)	ESCC	-	Burn-in(168H / 85°C / 50% rated current) is mandatory on each lot. Specific derating shall be applied.
	MIL	MIL-PRF-23419	
	Other	-	
Heaters	ESCC	ESCC 4009 level C	
	MIL	-	
	Other	GSFC S-311-P-079	
Procured inductors, molded & chip	ESCC	ESCC 3201 level C	
	MIL	MIL-PRF-39010 EFRL R min MIL-STD-981 class S	
	Other	-	
Inductors & Coils, non-molded	ESCC	ESCC 3201 level C	
	MIL	MIL-STD-981 class S	
	Other	-	
Procured transformers	ESCC	ESCC 3201 level C	
	MIL	MIL-PRF-39010 EFRL R min MIL-STD-981 class S	
	Other	-	
Integrated circuits	ESCC	ESCC 9000 level B	PIND test (Note 2)
	MIL	MIL-PRF-38535, class V or S	
	Other	-	
Integrated circuits Microwave (MMIC)	ESCC	ESCC 9010 level B	PIND test (Note 2)
	MIL	MIL-PRF-38535, class V	
	Other	-	
Microwave passive parts (circulators, isolators)	ESCC	ESCC 3202 level B	
	MIL	-	
	Other	-	
Microwave passive parts (coupler, power dividers)	ESCC	ESCC 3404 level B	
	MIL	MIL-DTL-23971, "space flight"	
	Other	-	
Microwave passive parts (attenuators, loads)	ESCC	ESCC 3403 level C	
	MIL	MIL-PRF-39030 (loads) S letter (screened parts) MIL-DTL-3933 (attenuators) S letter (screened parts)	
	Other	-	
Oscillators (hybrids)	ESCC	ECSS Q-ST-60-05 Level 1	
	MIL	MIL-PRF-55310 (class 2) level S	
	Other	-	

Category	Quality Requirement		
Resistors, fixed, film (RNC, RLR or MBx xxxx type, except RNC90)	ESCC	ESCC 4001 level C	
	MIL	MIL-PRF-55182 EFRL R min MIL-PRF-39017 EFRL R min	
	Other	-	
Resistors, high precision, fixed, metal foil (RNC90)	ESCC	ESCC 4001 level C-	100 KΩ max allowed. (Values above 100 KΩ are not suggested for space flight use)
	MIL	MIL-PRF-55182/9 EFRL R min	
	Other	-	
Resistors, network, thick film	ESCC	ESCC 4005 level C	Lot sample DPA is required prior to use. Particular attention should be paid to the integrity of the termination attachment to the resistive element (i.e., cracked solder joints, misaligned connections, etc.)
	MIL	MIL-PRF-83401 M part number level	
	Other	-	
Resistors, current sensing (RLV type)	ESCC	-	
	MIL	MIL-PRF-49465	
	Other	-	
Resistors, power, fixed, wirewound (RWR type)	ESCC	ESCC 4002 level C	
	MIL	MIL-PRF-39007 EFRL R min	
	Other	-	
Resistors, power, fixed, wirewound, chassis mounted (RER type)	ESCC	ESCC 4003 level C	
	MIL	MIL-PRF-39009 EFRL R min	
	Other	-	
Resistors, precision, fixed, wirewound (RBR type)	ESCC	-	Diameter of wires shall be greater than 0.03mm.
	MIL	MIL-PRF-39005 EFRL R min	
	Other	-	
Resistors, fixed, film, high voltage (RHV type)	ESCC	ESCC 4001 level C	
	MIL	-	
	Other	-	
Resistors, fixed, thick and thin film chip	ESCC	ESCC 4001 level C	
	MIL	MIL-PRF-55342 EFRL R min	
	Other	-	
Relays, electromagnetic, latching and non-latching	ESCC	ESCC 3601, level B ESCC 3602, level B	Products based on MIL-PRF-39016 are allowed with ESCC screening.
	MIL	MIL-PRF-39016 EFRL R min + ESCC screening according to chart 3	
	Other	-	

Category	Quality Requirement		
Solar cells	ESCC	PSS-01-604	
	MIL	-	
	Other	-	
Switches, thermostatic	ESCC	ESCC 3702 level B	
	MIL		
	Other	GSFC S-311-641	
Switches, non RF	ESCC	ESCC 3701 level B	
	MIL	MIL-PRF-8805	
	Other	-	
Thermistors	ESCC	ESCC 4006 level B	
	MIL	MIL-PRF-23648	
	Other	GSFC S-311-P-018	
Transistors, low frequency	ESCC	ESCC 5000 level B	PIND test (Note 2)
	MIL	MIL-PRF-19500, JANS	
	Other	-	
Transistors, High frequency, (bipolar and GaAs)	ESCC	ESCC 5010 level B	PIND test (Note 2)
	MIL	MIL-PRF-19500, JANS	
	Other	-	
Opto-couplers, Opto-discrete devices	ESCC	ESCC 5000 level B	PIND test (Note 2)
	MIL	MIL-PRF-19500, JANS	
	Other	-	
Hybrids	ESCC	ECSS-Q-ST-60-05 level 1	
	MIL	MIL-PRF-38534 class K	
	Other	-	
Surface Acoustic Waves (SAW)	ESCC	ESCC 3502 level B	
	MIL	MIL-PRF-38534 class K	
	Other	-	
Charge Coupled Devices (CCD)	ESCC	ESCC 9020 level B	
	MIL	-	
	Other	-	

Note 1 : For ceramic capacitors procured through ESA or MIL specifications but in an extended, non-qualified, range of value or not belonging to ESA QPL or MIL QML/QPL, the humidity, steady state, low voltage test (c.f. ESCC 3009, § 5.2.2) is mandatory if $U \leq 50V$ and $C \geq 1\mu F$.

Note 2 : Particle Inducted Noise Detection (PIND) test is applicable to all cavity packages of active components, except non-metal packaged diodes.

- For semiconductor devices the JANS criteria is applicable per MIL-PRF-19500 : The lot shall be submitted to 100% PIND testing according to test condition A (per method 2052 of MIL-STD-750).

- For integrated circuits the Class level S criteria is applicable per MIL-PRF-38535 :
The lot shall be submitted to 100% PIND testing according to test condition A (per method 2020 of MIL-STD-883).

APPENDIX L. 청정도 및 오염관리 (CLEANLINESS & CONTAMINATION CONTROL)

L.1. GENERAL

The Subcontractor shall maintain a contamination control program applicable to the End Product. The program shall consist in defining the specific cleanliness requirements and setting forth the approaches to meeting them, and then in implementing the control and monitoring activities.

The contamination sensitive components shall be identified and shall be controlled specially. Contaminants include all materials of molecular or of particulate nature whose presence degrades hardware performance. The source of the contaminant materials may be the hardware itself, the test facilities, and the environments to which the hardware is exposed. All hardware and support equipment shall be received by Customer (Satellite System Integrator) in visibly clean condition.

L.2. CONTAMINATION CONTROL

The Subcontractor shall define a contamination allowance for performance degradation of contamination sensitive hardware such that, even in the degraded state, the hardware will meet its mission objectives. The contamination allowable shall be assessed in a timely manner such that results can be used to assess the adequacy of and, if necessary, to modify the design of the hardware.

In case the Subcontractor develops contamination sensitive equipment, he shall provide contamination control plan. This plan shall describe methods for controlling contamination and for ensuring that the contamination allowance is not exceeded. It shall identify the controls, inspections, tests, analyses, and documentation necessary for measuring and maintaining the levels of cleanliness required during the various phases of the hardware lifetime including the spacecraft system AIT and Launch preparation period.

In case the Subcontractor develops contamination sensitive equipment, contamination analysis shall be performed and its result shall be submitted to Customer (Satellite System Integrator) for review. This analysis will show Procedures, standards, and specifications referenced in the contamination control plan shall be available for review at the Subcontractor's facilities.

L.3. EQUIPMENT CLEANLINESS REQUIREMENTS

The Subcontractor shall define specific cleanliness criteria suitable for his process and the End

Product. General rules are listed below:

- a. Selection of materials will be based on TML and CVCM parameters. The outgassing criteria shall be $TML < 1\%$ or $CVCM < 0.1\%$.
- b. Elements with organic material shall be baked out during 48 hours at 65 °C or equivalent conditions according to the material characteristics.
- c. Airborne cleanliness class for Integration or assembly operation shall be better than 100,000 class and shall be defined to ensure that the contamination allowance is not exceeded and it shall be specified in the contamination control plan.
- d. The Subcontractor shall monitor molecular contamination and particulate contamination. The contamination budget at delivery shall satisfy the criteria defined by Contamination Analysis results.
- e. For the cleanliness critical hardware, particulate cleaning shall be done by vacuum cleaning only. Molecular cleaning may be done with an approved procedure.

L.4. CLEANLINESS REQUIREMENTS FOR TRANSPORTATION

The End Product shall be double packed within sealed plastic bags for the transportation or storage phases:

- a. The inner bag shall be sealed with cleaned equipment inside and with no loose parts which could damage the equipment.
- c. The outer bag shall be sealed with the inner bag inside and desiccant bags. Even if the desiccant bag is damaged, the hardware shall not come in contact with loose desiccants.
- c. The materials used for equipment packaging, such as plastic bags and foam, shall be designed with materials presenting no free particles and no organic materials outgassing.
- d. If special packing requirements are required by the nature of hardware, those are described in the contamination control plan.

L.5. VACUUM BAKE OUT

Materials which are considered as contamination critical shall be submitted to vacuum bake out. The bake out parameters shall be agreed with Customer (Satellite System Integrator) on a case-by-case basis. These parameters must be identified in the Material List.

An outgassing test must be performed on the materials after vacuum bake out to demonstrate compliance with the requirements of Section L.3. In all instances, a test reference from an ESA or NASA approved source must be provided to assure the accuracy of the data.

All of the deliverable flight items shall undergo vacuum environment before delivery.

APPENDIX M. 소프트웨어 품질보증 (SOFTWARE QUALITY ASSURANCE)

M.1. GENERAL

The Subcontractor shall establish a Software Assurance Program which includes the entire software development processes and the methods used to ensure software quality.

The Software Assurance Program shall include the processes such as requirements definition, software design, coding, code review, software configuration management, testing, release management, and product integration.

The Software Assurance Plan shall include the followings:

- a. The software development cycles (milestones, input, output, etc.) the types of activities (verification, validation, tests, etc.) on each development phase
- b. The methods, tools, and rules to be applied
- c. Development environment implemented
- d. Dedicated actions to inspect Lower Tier Subcontractor
- e. Quality arrangements for the warranty phase

M.2. LIST OF SOFTWARE

The Subcontractor shall prepare list and keep up to date a list of all software components which are part of the End Product under his responsibility. The list shall include:

- a. Name and identification in the product tree structure
- b. Reference of the associated requirement specification
- c. Name of the provider
- d. Criticality of the software component
- e. Programming language and the volumes of associated code specifying the method or tool for calculation of these volumes
- f. For re-use software, the overall rate of re-use
- g. Development machine and its operating system
- h. Target machine and its operating system

A set of milestones shall be defined for each software component to be consistent with the product development cycle and criticality.

M.3. MANAGEMENT OF RESOURCES

The Subcontractor shall perform performance budget evaluations during design for memory

occupation and CPU load during execution.

Budget analysis results of resources for on-board software shall be provided to Customer (Satellite System Integrator) during Design Review.

M.4. SOFTWARE CONFIGURATION

Software configuration document is a living document. It remains available at project milestone and is delivered with any software for validation or acceptance. The configuration document shall explicitly identify the differences between the version delivered and the previous delivered version. It shall be supported by an information technology tool.

The component of a deliverable software product shall be identified and marked when configured for delivery with a non-removable label on each physical medium. It shall include at least the name of the software, its version number, and its configuration document reference.

M.5. DOCUMENT MANAGEMENT

The following documents shall be managed in parallel with related software components:

- a. Documents describing development or quality procedures to be implemented during the software life cycle
- b. Documents derived from software product development, including the documentation intended for operators and users of the software system.

M.6. SOFTWARE SPECIFICATION

The software specifications shall define all topics necessary to satisfy applicable requirements. Each requirement in the specification shall be identified by a unique reference.

M.7. DESIGN

The design description shall cover the hierarchy, dependency, interfaces of the software components, dynamic sequencing of components, and data flow checks.

Software design shall minimize dependencies with respect to the operating system and the hardware in order to contribute to software maintainability and portability.

M.8. CODING

Programming language adapted to the software product and to the design method shall be used. Coding rules and conventions for consistent naming shall be defined for each programming language. Dedicated coding rules shall be defined to avoid using risky instructions and use the real time executive retained to best effect. In particular, the following shall be prohibited:

- a. Dynamic memory allocation
- b. Use of generic characteristics.

The source code shall subject to configuration management.

M.9. TESTS

The test strategy shall define test level, types of test, and test coverage. For on-board software, the test strategy shall define:

- a. The target processor environment which shall be simulated or shall be executed really on the development chain
- b. The tests that will be performed on the development processor and those performed on the real target processor (validation shall include central flight software coupling with the target processor)
- c. How are handling tests of software integrated in an equipment
- d. How are handling re-used software

When requirements are not covered by test, verification activities such as simulations, inspection, or analysis shall be performed.

After validation, the areas affected by changes or corrections shall be identified and subject to re-testing. In the event of re-testing, any documentation related to tests (test case specification, procedures, report, etc.) shall be updated.

M.10. DELIVERY, INSTALLATION, AND ACCEPTANCE

Before the software is presented to Customer (Satellite System Integrator) for acceptance, the Subcontractor shall ensure that:

- a. The source and object codes supplied
- b. All agreed changes have been implemented
- c. All nonconformances have been declared and resolved
- d. All necessary facilities are available

Once acceptance tests have been performed, the Subcontractor shall prepare a report which ensure conformance with software requirements and establish the conclusion concerning the test result for the software product subjected to such tests accepted, accepted on condition, or rejected.

M.11. MAINTENANCE PREPARATION

Maintenance plans and procedures shall deal with maintenance in terms of correction and adaptation. Any adaptation or correction to the software product shall be covered by non-

regression tests. Any adaptation or correction to the software shall be documented in compliance with the documentation management and product configuration management procedures.

M.12. PROCURED SOFTWARE

The term 'Procured Software' covers both software bought off-the-shelf and software used after having been developed outside the contract to which the present requirements apply.

The choice of Procured Software shall be described and proposed to Customer (Satellite System Integrator) in the form of a list of software components. The list of software components shall include as a minimum:

- a. Order criteria (version, options, extensions, etc.)
- b. Intellectual ownership constraints
- c. Acceptance inspection criteria (qualification, documentation, etc.),
- d. Maintenance organization
- e. Standby solutions if the product were unavailable

Any software procured to be used in a software product shall be identified and registered by configuration management for that product, as for developed software.

붙임#4. 한국항공우주연구원 저장성 이원추진제 추력기 보유기술

1. 10 N급 이원추진제 추력기 설계 및 해석 기술
 - 10 N급 이원추진제 추력기 분사기 설계/해석
 - 10 N급 이원추진제 추력기 연소실/노즐 설계/해석
 - 10 N급 이원추진제 추력기 설계(안)
2. 10 N급 이원추진제 추력기 조립, 시험 및 평가 기술
 - 10 N급 이원추진제 추력기의 밸브, 분사기, 연소실/노즐 조립 기술
 - 10 N급 이원추진제 추력기의 환경 및 성능 시험 기술
 - 10 N급 이원추진제 추력기의 연소 시험 성능 평가 기술