SST Programme:
Risk Management Plan

SST-PRO-PLA-004

Version 2c

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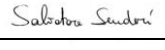
Salvatore Scuderi (INAF)		SST-STR PM
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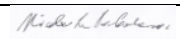
Nicola La Palombara (INAF)		SST-PRO PRQM
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1 Introduction

1.1 Scope & Purpose

The SST Risk Management Plan (RMP) is aimed to provide to SST-ESC a plan for the identification of risks scenario and potential causes. The risk shall be managed in the framework of SST Consortium responsibilities.

All the SST risk impacting the CTA level shall be treated jointly with CTAO team in compliance with the CTAO Risk Management Plan [AD 2].

A summary of the methodology for developing the Risk Analysis is provided in the first paragraphs. The methodology has been developed by the SST Consortium on the basis of the experience acquired performing risk analyses in the frame of others programs.

The purpose of this plan is to specify the SST Programme risk management processes and describe the methods to be implemented in the SST Consortium and translated into management requirement documents to the industrial contractor, where applicable.

1.2 Applicable Documents

[AD1] CTA Project Management Plan, CTA-PLA-MGT-000000-0003_1c, Version 1.2, 25 May 2020
[AD2] ISO 31000, Risk Management

1.3 Reference Documents

[RD1] ECSS-M-ST 80C, Risk management (31 July 2008)
[RD2] Risk Management (per int PC meeting 4-5 Dec 2017- Cesar Ocampo)

1.4 Definition of Terms and Abbreviations

1.4.1 Abbreviations and Acronyms

AIT	Assembly Integration and Testing
AIV	Assembly Integration and Verification
APM	AIV/AIT Project Manager
BKO	Bridging phase Kick-Off
CDR	Critical Design Review
CPM	Camera Project Manager
CTA	Cherenkov Telescope Array
CTAO	Cherenkov Telescope Array Observatory
FAR	Final Acceptance Review
DR	Delivery Review
DVER	Design Verification Engineering Review
ERIC	European Research Infrastructure Consortium
IKC	In Kind Contribution
ESC	Executive Steering Committee
INAF	Istituto Nazionale di Astrofisica
KO	Kick-Off
MPIK	Max-Planck-Institut für Kernphysik
OdP	Observatoire de Paris
PA	Product Assurance
PBS	Product Breakdown Structure
PR	Product Review
PMP	Programme Management Plan
PO	Project Office
PQR	Production Qualification Review
PRM	Programme Manager
PRR	Production Readiness Review
PSE	Programme System Engineer
PSL	Paris Sciences et Lettres University
QA	Quality Assurance
QM	Quality Manager
RAMS	Reliability, Availability, Maintainability, and Safety
SE	System Engineer
SPM	Structure Project Manager
SST	Small Size Telescope
T-TRR	Telescope Test Readiness Review
TRR	Test Readiness Review
WBS	Work Breakdown Structure

WP Work Package

1.5 Evolution of this Document

This document should be fixed once consolidated in the bridging phase and used as applicable document for SST programme risk management. The document will be modified when needed to follow the project evolution.

2 SST Risk Management Process

2.1 SST Risk Management Board

The evaluation of risk in the framework of SST Consortium is performed by the SST Risk Management Board (SST-RMB) which is composed by members from all the entities of SST Consortium. The SST Consortium organization and the relative key-roles are reported in Figure 2-1.

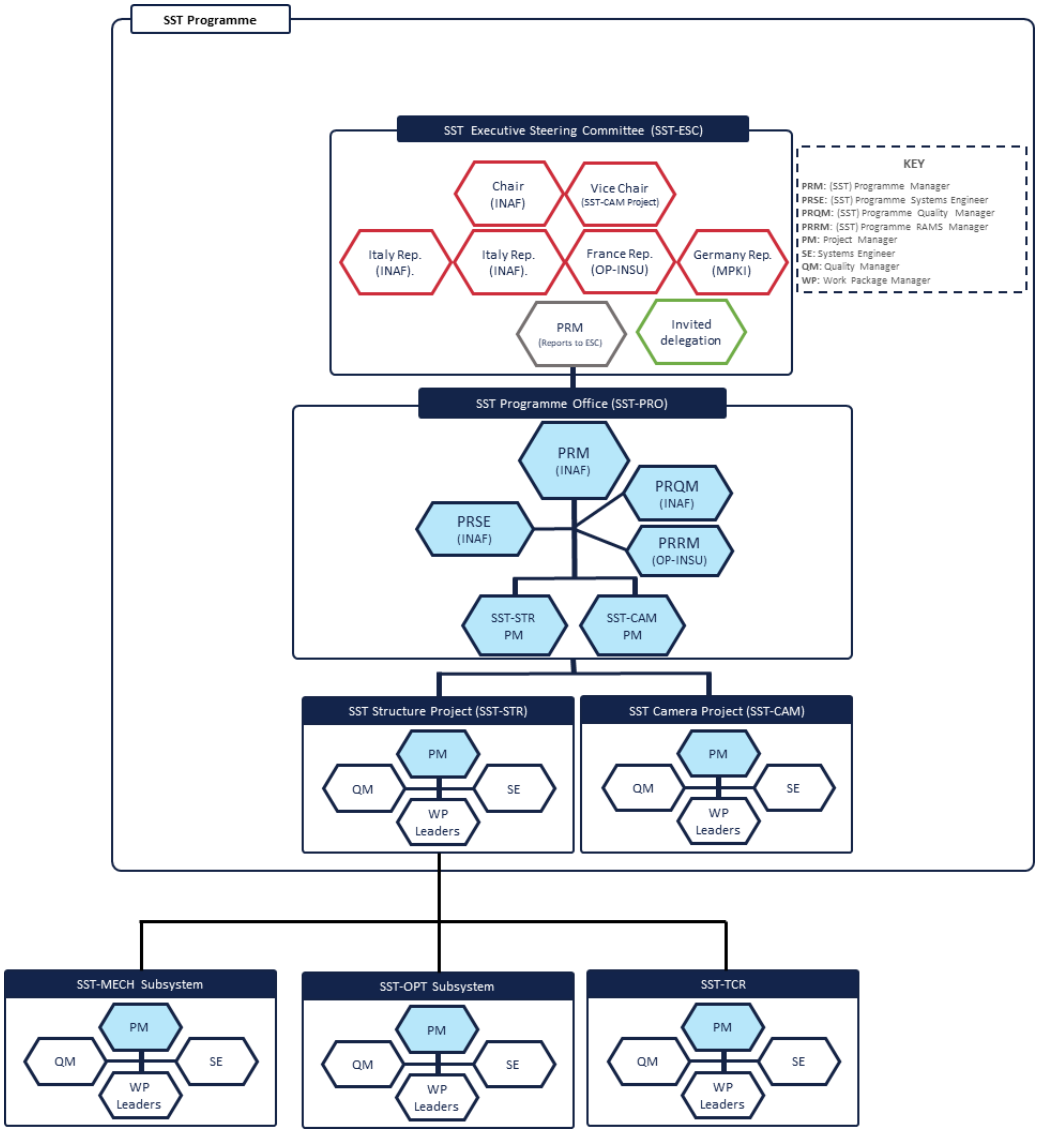


Figure 2-1: The SST Programme organisation and key-roles.

The SST Risk Management Board is described in the following.

SST Project Managers are in charge of the risk assessments and for the assigned mitigation actions. The **Project System Managers** provide support to facilitate Risk Management activities.

SST Programme Manager is to approve any risk register released from their project or subsystem. SST-PRM acts as SST Consortium Risk Coordinator (RC) and is the liaison between SST-RMB and CTA-RMB.

SST-PRO are to supervise and approve for the aspects related with the achievement of SST Programmes success criteria prior the final release versus CTAO.

Risk Registers are reported in the format described in Annex 1. Each risk has a progressive identification ID yyy-xxx (xxx=Project/Subsystem) assigned by the SST-RMB. The risks elevated to SST-PRO level have an identification ID SST-yyy assigned by the SST-RMB.

The Risk Coordinator shall maintain the directorate-level Risk Register and distribute it to ESC in the occurrence of:

- Risk updating
- Progress meeting with CTAO

The approved Instrument Risk Register will be used to interface with the CTA-PO. In particular:

- As the basis for SST-PRO to decide which risks shall be proposed to be transferred to CTAO Level
- To be used as input to the periodical Risk Management Board

All the SST Programme risks transferred at the CTAO Level shall be treated in conformance with the plan defined in CTAO Risk Management Plan [AD 2].

2.2 Risk Assessment Process Definition

Where the trade-offs and the engineering design definition process are driven by a positive way of thinking, the risk analyst shall be driven by a negative approach, such that to identify all the possible drawbacks inherent to the project/Subsystem.

Different methods and different parameters can be chosen for evaluating the risk inherent to a project/Subsystem. The method shall be anyway compatible with the typology of project (known applications, new applications in known environment, new application implying new technologies development, etc.) and the level of definition of the project.

According to [RD 1], the risk analysis and management process shall be performed by considering the following recursive steps

- Define risk management implementation requirements
- Identify and assess the risks
- Decide and act (decide if the risk may be accepted, reduce the risks, recommend acceptance)
- Monitor, communicate and accept risks

The methodology has been defined in the attempt of merging two main needs identified for the risk analysis in the past projects:

- capability of analyzing projects with specific peculiarities (mission with severe constraints in not well-known environment)

- capability of driving effectively the system development, not only providing generic risk factors or likelihood of risks, but a method for identifying and controlling the risk scenarios along all the phases of the project development up to the system qualification.
- Identification of a primary list of Risk Factors and potential consequences relevant to the mission, in order to define a basis for proceeding with a further detailed analysis;
- Development of Fault Tree on the basis of the identified Risk Factors such that to identify:
    - top event causing Telescope unsuccessful
    - risk scenarios leading to the top event (risk scenarios consequences)
    - causes leading to each risk scenarios
- Iteration of the information on Risk Factors and Scenarios to improve their definition;
- Definition of control measures methodology to be applied in next project phases;
- Quantitative assessment of the risk scenarios on the basis of engineering judgment;
- Risk scoring according to risk index (criticality);
- Re-assessment of the system in front of implemented controls and risk level such that to ensure that the risks are effectively controlled.

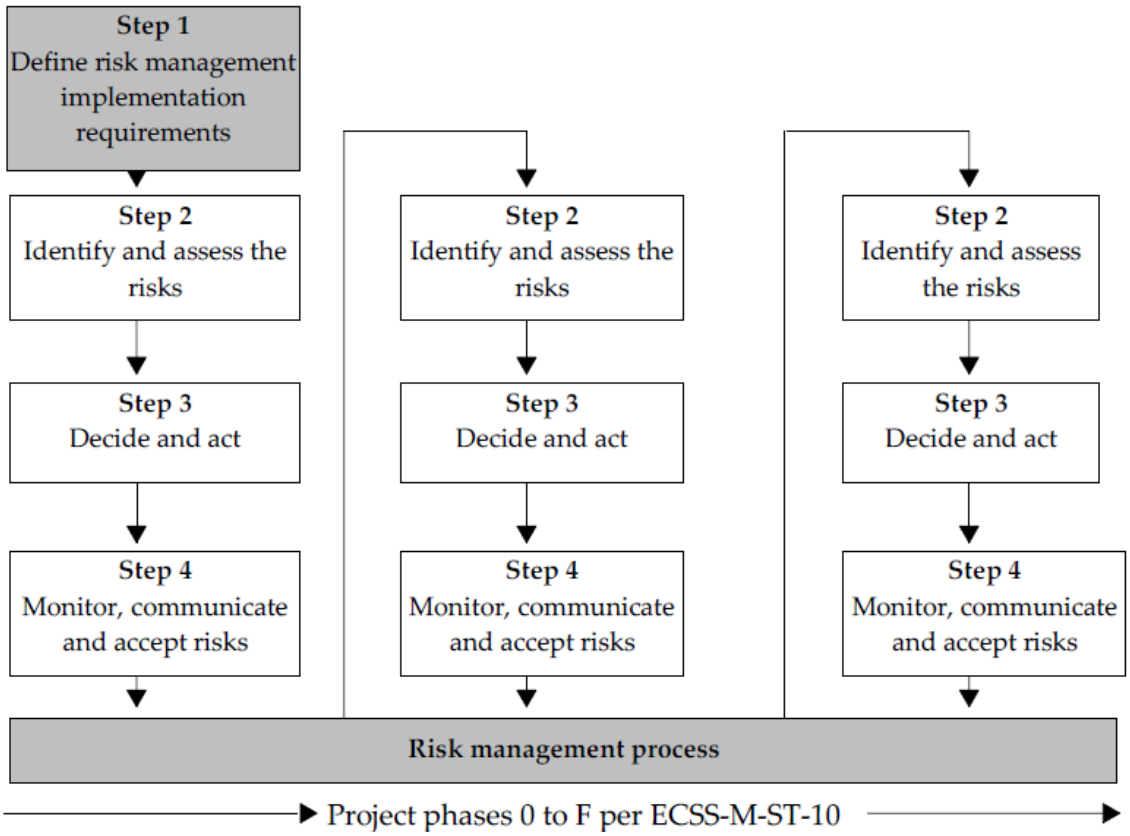


Figure 2-2: The steps and cycles in the risk management process

3 Risk Evaluation

To evaluate the risk inherent to each scenario a specific method from CTAO can be adopted. A common metric allows the elevation of SST Risk to CTA Risk level without misunderstanding induced by the conversion of the SST team standard risk metric (ECSS and practice adopted by SST-CAM team) with the CTA risk metric (at the time being partially defined only [RD2]).

Waiting a CTAO metric for SST Programme risk evaluation a temporary methodology (well proven in other projects) is presented in this document.

3.1 Risk Identification

For purposes of this document, the term "risk" is defined as any scenario that, if/when encountered, may have a negative impact on the project's goals and objectives. Such scenarios may lead to degraded performance with respect to one or more performance measures e.g., scenarios leading to:

- programme failure;
- scenarios leading to inability to meet all the programme requirements;
- scenarios leading to exceeding on-site resources limits (mass, power, data throughput) ;
- scenarios leading to cost overruns wrt money matrix allocation;
- scenarios leading to schedule slippage.

Risk identification may occur at any point during the programme/projects lifecycle. The risk identification process will address the following:

- Is the concern a risk? (Could it result in an undesirable situation or circumstance and have a realistic likelihood of occurring?)
- Is the concern already covered in forward work? (If so, then it is not a risk.)
- Can the concern be addressed by funds without going through the risk management process? (Management may decide to apply those funds and include it in forward work; therefore, it is not a risk, assuming the funded task provides full mitigation.)
- Is the concern a known risk (duplicative)? (Review the existing risk and, if necessary, update the description and context.)
- Is the concern an issue? (Not a risk because the likelihood is 100%—the threat has already occurred).

For all risk scenarios identified (also referred to as "concerns" in this document) the risk owner will write a risk statement using a risk statement formula, which captures the conditions that, if they exist, have the possibility of producing a particular consequence. The risk statement formula options are reported in the following.

a) Given [CONDITION], there is a possibility that [CONSEQUENCE] will occur.

b) Given [CONDITION], there is a possibility of [DEPARTURE] adversely impacting [ASSET].

c) Given [CONDITION], there is a possibility of [DEPARTURE] adversely impacting [ASSET], thereby leading to [CONSEQUENCE].

[CONDITION], Current situation causing concern, doubt, or uneasiness. Must be:

- Fact
- Reality Based

- Actionable
- No Uncertainty

[CONSEQUENCE]

Single phrase

Describes negative outcome

[DEPARTURE]

Possible change from baseline project plan

[ASSET].

Primary Resource that is affected

3.2 Risk Ranking Criteria

Likelihood

It has been decided to drive the identification of the likelihood via a guideline that associates to each likelihood value (from 1 to 5) a specific level of definition for the risk factors above identified (environment knowledge, mission constraints, technologies, manufacturing)

Therefore, a Risk Scenario will have a high or low likelihood, according to the:

- level of qualification of the process,
- maturity of technologies and products,
- level of knowledge on the environment,
- level of definition of the requirements,
- level of definition relevant to the specific elements (equipment, environment, manufacturing processes, requirement) participating to the scenario under evaluation.

Typical likelihood is reported in Table 3-1.

Table 3-1 : Risk Scenario Likelihood definition-The ranges are proposed taking into account SST team experience

Likelihood	Score	Definition
Maximum (Certain to occur, will occur once or more times per project)	5	- Undefined environmental conditions - Undefined requirements - Research level only, no application, and new technology. - New project beyond the status of the art. - New processes/ Need of new facilities
High (will occur frequently, about 1 in 10 projects)	4	- Numerous critical areas with missing environment definition - Numerous critical areas with missing requirement - Technologies experiment phases completed. - New project with reuse of qualified parts/ knowledge. - New processes/ Critical facilities
Medium (will occur sometimes, about 1 in 100 projects)	3	- Critical environment areas require definition - Critical areas require requirement definition - Qualified technologies, never applied in projects. - Numerous modifications of qualified product. - Important existing processes modification/ Facilities requirement modification
Low (will occur seldom, about 1 in 1000 projects)	2	- Minor environment areas need definition - Minor areas need requirement definition - Technology applied in space project, not operative yet. - Slight modifications of qualified product. - Improvement of existing processes/ Existing facilities
Minimum (will almost never occur 1 in 10000 projects)	1	- Defined environmental conditions - Minor areas need requirement definition - Developed and utilized technology. - Qualified products. - Existing processes/ Existing facilities

Each Risk Scenario will have likelihood defined via a scientific/engineering judgment aimed to identify the worst but appropriate condition that can be chosen between the different likelihood level definitions. The judgment shall be iteratively based on the analysis of each risk scenario cause, developed along the project life.

Consequence

The possible consequences of a risk have to be evaluated for the impact on the sectors identified in Table 3-2. The categories/subcategories adopted for SST are those of current CTAO draft risk organization [RD2].

Table 3-2: Categories and subcategories

Category	Subcategory
1. Management	Governance
	Funding
	Project Management
	Staff/organization
	Logistics
	Others
2. External	Legislation
	Regulatory
	Environmental
	Other work package
	Others
3. Technical	Requirements
	Interfaces
	Safety
	RAMS
	Others
4. Commercial	Procurement
	Contract terms
	Suppliers/vendors
	Others

The consequences of a risk are evaluated in terms of impact on product(s):

- Cost
- Schedule
- Performance (quality)

The consequence severity level shall be defined according to the worst case potential effect. A further qualitative evaluation is the impact inducted by the risk to the other teams (CTAO or the other sub-arrays teams).

Risk ranking criteria summary with the metrics adopted for SST are reported in Table 3-3.

Table 3-3 : Risk Ranking Criteria summary

Risk Level	Likelihood	Impacts			
		Cost Impacts	Schedule Impacts (days late)	Technical or SST Impacts	Impacts induced to CTAO/others teams
5	Certain to occur (at least once in a project) Very High	>30%	>30% of schedule elongation	Unacceptable product performance	Y/N
4	Will occur frequently (in 1 in 100 projects) High	20-30%	20-30% of schedule elongation	Inability to meet product full performances	
3	Will occur sometimes (in 1 in 1000 projects) Moderate	10-20%	10-20% of schedule elongation	High impact in product performances	
2	Will occur rarely (in 1 in 1000 projects) Low	<10%	<10% of schedule elongation	Some impacts in product performances	
1	Will almost never occur	Negligible	Negligible: impact of schedule recoverables by margins	Minor change in product performances	

Risk Index pattern

Figure 3-1 shows the pattern of risks proposed for SST Programme (to be adopted at Project level, too). The risks are organized in four classes:

- The Very High Level Risk (Red field)
- The High Level Risk (Red field)
- The Medium Critical ones (Yellow field)
- The Low Critical ones (Green Field)

The boundary identified by the thick line defines the threshold over that the risk is classified as top risk, which requires a primary attention in order to track the risk and the control measures.

Threshold

Threshold is defined in order to rank the risks. The matrix likelihood versus severity identified in Figure 3-1 shows the range or risk index with a preliminary thresholds for the three categories: Cost, Schedule and Technical/Mission.

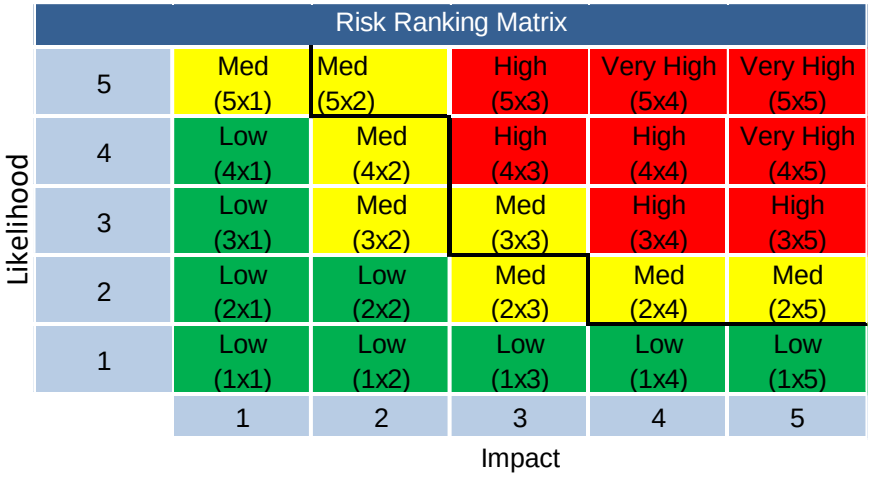


Figure 3-1: Risk pattern

Risk Approach

The approaches in risk investigation, tracking and control are summarized in Table 3-4.

Table 3-4 : Response Approach Definitions

Approach	Definition
R – Research	Investigate the risk until enough is known to decide what approach to take (i.e., mitigate, watch, accept).
W – Watch	Monitor the risks and their attributes for early warning of critical changes in impact, probability, timeframe, or other aspects.
M – Mitigate	Eliminate or reduce the risk by reducing the impact, reducing the probability, or shifting the timeframe.
E – Elevate	Transfer the management of a risk to the risk management structure at a higher organizational level.
A – Accept	Do nothing. The risk will be handled as a problem if it occurs. No further resources are expended managing the risk.
C – Close	The risk no longer exists, it is no longer cost effective to track as a risk, the risk is superseded or encompassed by other risks, or it has been mitigated.

The disposition shall be decided by the SST-ESC in case of elevation of the risk from "SST Telescope" to "CTA Observatory" on the basis of the conditions reported hereafter.

For risks dispositioned as "Research," the RMB will give direction on what information is to be gathered or assessed to support an additional disposition and the timeframe in which it should occur. The risk owner will be responsible for gathering the information unless otherwise directed.

For risks dispositioned as "Watch," the RMB—or if so assigned, the RC in collaboration with the SST-SE—will identify triggers (events or timeframes) that will provide early warning of significant changes in the likelihood or consequence of the risk.

For risks dispositioned as "Mitigate," the risk owner will identify ways to prevent the risk from occurring or reduce its impact or probability of occurring. Mitigation steps must be actionable and have defined due dates. This may include prototyping, adding tasks to the project schedule, adding resources, etc. Day-to-day risk mitigation activities will be enacted and directed by the SST-PRM.

For risks designated as "Accept," the risk will be tracked by the project; liens for cost, schedule, and technical will be levied as appropriate.

For risks dispositioned as "Elevate," the SST-Programme Manager will notify the SST-ESC chair as required.

Risks recommended for closure must be accompanied by credible rationale to support closure. If the mitigation actions have eliminated the risk or reduced it to an acceptable level, the likelihood and consequence are at very low levels, or the risk has become a problem, it will be considered for closure.

If the risk is superseded or encompassed by other risks, it can be considered for closure. The SST Programme Manager is the final authority on the closure of all project risks.

The RMB will determine the criteria for top/major risks. Top/major risks will be assessed at a higher priority and will have risk response planning, which may include both a risk mitigation and a risk contingency plan. Contingency plans, once approved and initiated, will be added to the project work plan and will be tracked and reported along with all other project activities.

Risk timeframe

The risk timeframe references are reported in Table 3-5.

Table 3-5 : Risk Timeframe definition

Near	The project must take action to mitigate the risk in the next 90 days; the project will be impacted by the risk in the next 90 days.
Mid	The project must take action to mitigate the risk in the next 90-180 days; the project will be impacted by the risk in the next 90-180 days.
Far	The project needs not take action to mitigate for at least the next 180 days; any impact will occur in > 180 days or within Consolidation Phase

3.3 Risk Mitigation

The risk mitigation actions shall be described in the field defined in annex 1. The mitigation shall be reported considering the time priority, e.g. Mitigation 1 is the first action to be implemented, Mitigation 2 is the second etc.

To define mitigation action the following criteria is adopted:

- for risks classified as “low” no mitigation actions are foreseen.
- For risk classified as “medium”, mitigation actions are optional.
- For risks classified as “high” and “very high” mitigation actions (and the associated estimated costs) are mandatory.

3.4 Risk Monitoring, Controlling and Reporting

The SST Programme Manager (the SST Risk Coordinator) is responsible for submitting updates of the ranking and status of the risk prior submission of new risk register to SST-ESC.

In case of SST Programme risk elevated to CTA Observatory the following approach shall be performed.

- Each risk owner is responsible for submitting updates of the ranking and status of his or her risks to the RC prior to RMB reviews.
- Top/major risks, submitted draft risks, and other risks as determined by the RC or PM will be reviewed at planned RMB meetings.
- The RMB will review all programme/subsystems risks prior to major life cycle reviews (e.g., Product Review, Critical Design Review, Production Readiness Review).

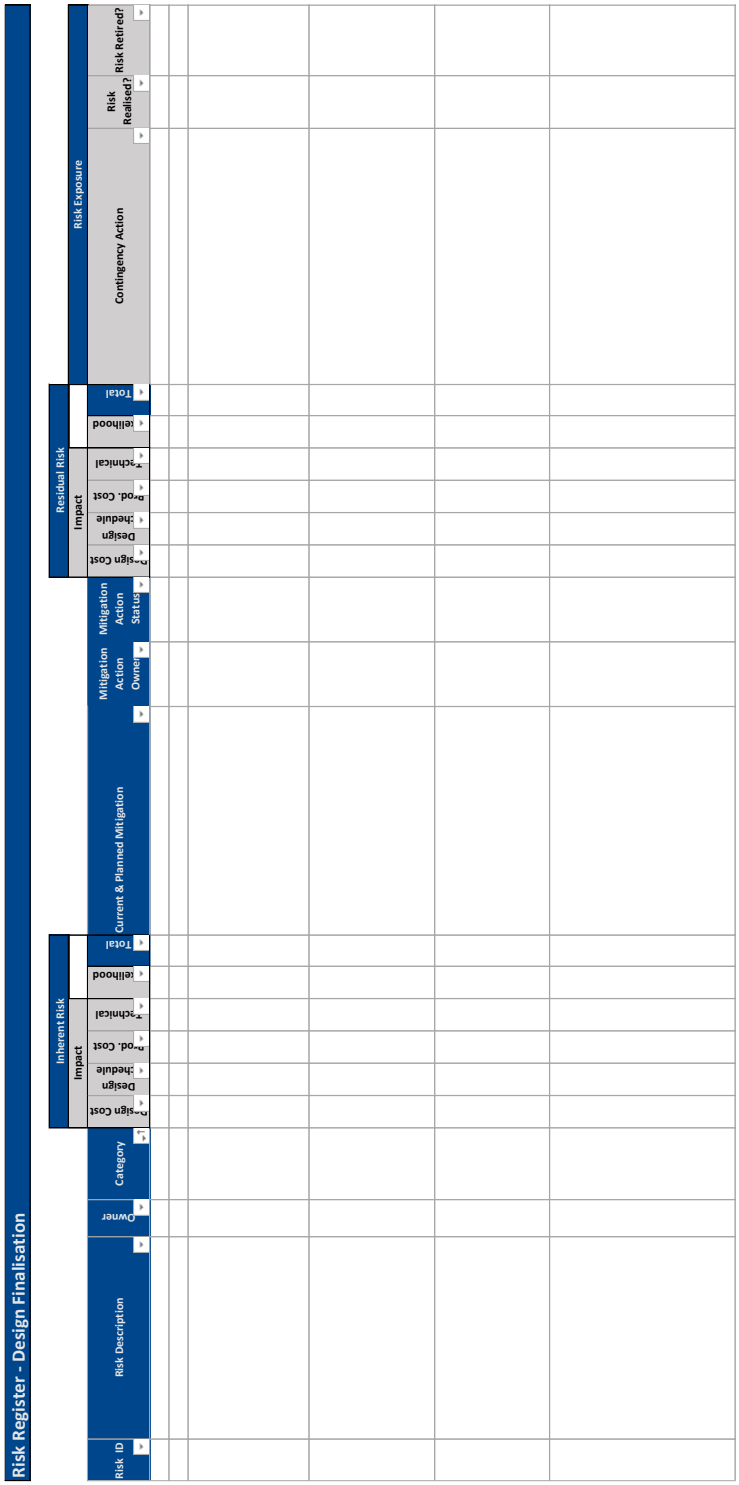
Control of risks is accomplished through the formal RMB reviews, during which relevant data will be assessed to determine the effectiveness of mitigation plans and any needed adjustments. When needed, interim RMB meetings will be called to deal with time-sensitive issues.

The status of the project risks will be presented at the Progress Review with CTAO (TBC).

3.5 Risk Decision Making Process

Risk decisions are made by consensus of the SST RMB. If consensus cannot be reached SST-ESC has ultimate authority to make risk decisions.

Annex 1: Risk Management Template



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