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MCAG TG2 Checklist for Instrument Project
MIRACLES

TABLE OF CONTENTS

1. Introduction	3
1.1 Definitions, Acronyms and Abbreviations	3
2. Purpose	3
3. Grading system	4
4. Review of MIRACLES	5
4.1 Technical Feasibility - Table of Motion	5
4.2 Technical Feasibility - Special Purpose Motion Control	5
4.3 Budget	6
4.4 Schedule	7
4.5 Risk analysis	7
4.6 Other Check Items	8
5. Conclusions and Recommendations	9

1. INTRODUCTION

MCAG are required to co-ordinate, manage and ensure integration of motion components into the ESS facility control system. The nature of the ESS project, with various in-kind partners providing complete instruments, provides many challenges in regards to integration and standardisation of components. It is imperative for the maintenance of the facility, that systems are designed and engineered in a consistent manner, therefore MCAG is always working to align the work of MCA or electrical engineering support teams across ESS partners.

1.1 Definitions, Acronyms and Abbreviations

Term	Abbreviation	Definition
EPICS	Experimental Physics and Industrial Control System	A set of software tools for creating distributed control systems
ICS	Integrated Control Systems	ESS division responsible for middle level control infrastructure
IOC	Input Output Controller	EPICS "server" software that stores parameters and allows sharing of these between different IOCs over a network
MCA	Motion Control & Automation	Instrument Technology for the low level motion control of mechanical components
MCAG	Motion Control & Automation Group	ESS group responsible for MCA
MCU	Motion Control Unit	Electrical hardware that received commands from an EPICS IOC and creates trajectories and electrical signals to send to the motors.
TG	Toll Gate	Each Instrument Project must pass a Toll Gate checkpoint to progress to the next Phase of the project.

2. PURPOSE

Phase 1 for each ESS Instrument Project is a planning phase for the subsequent phases 2 - 6. During Phase 1 each instrument should decide what is going to be built, formulate the associated budget and identify resources needed to build it. This document is a review, completed by ESS MCAG, of the Preliminary Design (Phase 1) work performed by instrument teams and their MCA support teams and forms part of the Tollgate 2 assessment. In order to proceed till the next phase a project must receive an overall approval.

Only motion control and automation aspects of the instrument design have been considered, except where it is considered they will significantly influence or interact with the motion control and automation system. The information required in the following sections should be included in the Instrument Team's documentation submitted for the TG2 review.

Although the instruments teams and the partners MCA support teams are in principle free in choosing the form to collect the appropriated information for TG2 documentation, ESS MCAG strongly recommends to follow the order and definitions given in ESS-0049514. They will match with the review criteria below and ensure enough information is available for ESS MCAG to smoothly review the instrument project for TG2.

3. GRADING SYSTEM

The assessment consists of a simple traffic light grading system. A number of criteria or sub-categories are considered and given an individual grading; which will then form an overall grade for the complete MCA aspects of the project. The following sections aim to reduce the subjectivity of the assessment. It will list the specific tasks that MCAG feel should be completed during Phase 1. The traffic light colours have the following interpretations:



GREEN: All aspects of the criterion in question have been addressed satisfactorily to permit endorsement by the MCAG to the detailed design phase.



ORANGE: Some aspects of the criterion in question have not been addressed satisfactorily. However, if additional information is supplied, MCAG endorsement of the instrument to the detailed design phase may be possible.



RED: Some aspects of the criterion in question are in serious doubt. Additional information and serious consideration by the NSS management is necessary to continue commencement to the detailed design phase



WHITE: Not applicable

Each of the following criteria will be assessed and given a traffic light colour. The criteria that will be assessed are summarised at the end of the document in table form and consist of the following:

- **Technical Feasibility:** The technical feasibility of the proposal will primarily stem from the Table of Motion for the generic motion control axes but also from the description of the special purpose motion solutions (if any).
- **Budget Completeness:** The budget will be checked to ensure that nothing has been omitted. For this reason it is important to present the budget (at least to MCAG) so that it is broken down to an adequate level to allow this.
- **Schedule:** Schedule will be most important in projects where development is required. The schedule of the whole project will be considered and if there are unrealistic timelines MCAG will flag this.
- **Risks Analysis:** A risk analysis should be conducted to where deemed necessary.

4. REVIEW OF MIRACLES

4.1 Technical Feasibility - Table of Motion

The MCA Table of Motion is an important component of the planning for Phase 1. The Table (in the form of an Excel spread sheet and supplied as template by ESS MCAG) must be completed as accurately as possible. Refer to section 4.2.1 of *ESS-0049514* for full details on how to complete the "Table of Motion", definition of parameters etc.







All sections of ESS MCA Table of Motion Excel spread sheet have been completed for each axis.	
All safety shutters have been included in the table as an axis.	
Other pneumatic actuators have been included in the table (if applicable)	
Special environmental conditions have been identified for each axis (if applicable)	
Special relationship between axes (gear ratio, synchronisation etc.) have been identified (if applicable)	
Similar or identical multiple axes have been identified (if applicable)	


Table 1 Checklist for MIRACLES Table-of-Motion

Comments:

- In the table of motion there are two shutters included. In the description of the instruments they have just one.
- The use of an hexapod is envision as soon as the Operation budget is available, this is a very complex application and it is not specified if it is optional or they will for sure will go with the hexapod.

4.2 Technical Feasibility - Special Purpose Motion Control

In some circumstances a special purpose control solution may be desired over the generic motion control solution. Instead of completing the Table of Motion a more detailed description of the technical solution is required. Refer to section 4.2.2 of *ESS-0049514* "Special Purpose MC".

Justification is provided stating why the special purpose motion is necessary or desired.	
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The proposed special purpose motion solution has been described in adequate technical detail including interfaces to other technical systems.	
At least one alternative has been proposed and reason is given as to why this not as desirable.	
A proposal how to integrate the control system into EPICS has been given.	








Table 2 Checklist for MIRACLES Special Purpose Motion

Comments:

- As a sample positioning an hexapod is mentioned and there is nothing specified about the hexapod or other alternatives instead of the hexapod. The hexapod is a complex system that has to be look into it in detail.

4.3 Budget

A budget must be provided as part of the TG2 submission for the Instrument Project. MCAG will assess this budget with regards to motion and automation in particular making sure the following points are satisfied. Refer to section 4.3 of *ESS-0049514* "Tasks List for Phase 1 - Budget" for additional information on how to form the budget, what should be included, definitions etc.

Instrument budget for MCA is broken down into the three MCAG deliverables: Generic Motion, Special Purpose Motion Control and Electronics and Control Racks.	
Figures are given for labour and non-labour for each of the three deliverables.	
Each of the figures is broken down in a similar manner to that described section 4.3.3 of <i>ESS-0049514</i> .	
Special purpose motion control (if any) e.g. robots, hexapod, piezo motors control have been identified and included in the budget.	
Sufficient budget is allocated for electrical drawings.	
An estimate for the number of electrical cabinets and/or racks is given for budget purposes.	
Instruments components that require a SAT/FAT have been identified and included	


in budget (either MCA specific or Instrument budget).	
All development costs for motion control (if any) been included in the budget.	

Table 3 Checklist for MIRACLES MCA Budget

Comments:

- If the Hexapod is used in it proper budget it has to be included the costs for the integration with the generic MCU. Normally an hexapod will be provided with its own controller.

4.4 Schedule

A schedule as described in section 4.3.7 of *ESS-0049514* "Schedule" should be included in the documentation if applicable. MCAG will assess the documents and flag any unrealistic timelines according to the next criteria.





Sufficient information exists in the Toll Gate 2 instrument documents for the schedule of the MCA work units.	
Milestones are identified throughout all stages of the project in regards to MCA.	
Important schedule links between MCA work units and other parts of the instrument projects are identified.	
A schedule for a development work unit (if any) has been included in the documents.	


Table 4 Checklist for MIRACLES MCA Schedule

Comments:

- <Comments here>

4.5 Risk analysis

Refer to section 4.4 "Risk Analysis" of *ESS-0049514* for complete guidelines on what should be considered for a risk analysis.

Axes that may be difficult to implement with the generic solution have been identified e.g. high speeds/accuracy/repeatability/stability/demanding environment.	
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Technical risk analysis of special purpose motion has been performed and the risks and mitigations identified.	
All moderate technical risks (if any) are addressed or an alternate solution stated.	

Table 5 Checklist for MIRACLES Risk Analysis

Comments:

- There is no detail information about the hexapod or alternate solutions. It might be a very big and complex thing to integrate.

4.6 Other Check Items

Each instrument project is different, for this reason sometimes more information will be required than that which is listed in the previous sections. Some of the things that MCAG may require further information and will check in the review include:


Information on any special shutters e.g. where they need to act as a dual device for safety and beam conditioning, or if they need some kind of special control or synchronisation.	<input type="checkbox"/>
Information on axes that may be linked to choppers e.g. if a chopper is mounted to a motion stage and should in and out of the beam.	<input type="checkbox"/>
Any special maintenance that may be required during operations period.	<input type="checkbox"/>
Procurement strategy for any long lead-time components.	<input type="checkbox"/>
Potential for training for personnel at ESS.	<input type="checkbox"/>
Identify resources available for EPICS integration for motion control.	
Plan for production and delivery of E-Plan electrical schematics.	<input type="checkbox"/>

Table 6 Checklist for MIRACLES other Check Items

Comments:

- An Hexapod application might need a special development for the integration with EPICS

5. CONCLUSIONS AND RECOMMENDATIONS

Example comments:

MIRACLES is given an orange light for the overall proposal with regards to MCA aspects. The following detailed information is missing:

- In the TG2 documents for Sample Positioning the use of a hexapod is envisioned (with Init. Operations budget). There is no information provided for that application in regards of motion control. Because it does not concern the budget agreed in the Scope Setting meeting it is nothing that stops you passing the TG2. However, if it is an application that is envisioned as a sample positioning system, a lot of details and aspects have to be looked into.







Category of Criteria	Grade
Technical Feasibility	
Budget completeness	
Schedule	
Risk Analysis	
Other Items	
Overall	

Table 7 Grading for MIRACLES

Assessment performed by Federico Rojas Givaudan on behalf of MCAG.

Date: 2017-Oct-09