Udvalget for Forskning, Innovation og Videregående Uddannelser 2011-12
FIV alm. del Bilag 248
Offentligt

ESS Project Review

May 31st – June 1st

2012

Contents

1. Introduction

This is a very exciting time for European neutron users and the Panel wishes to congratulate both the Swedish and Danish Governments for supporting and driving forward the ESS project. This bold action should be an object lesson to other countries on how to drive innovation forward despite or rather as a positive reaction to the current economic climate in Europe. The project is now at a critical time as it seeks to move from the pre-construction phase to actual construction and the Panel feel privileged to have been asked to make this review at this time.

The achievements made so far by the ESS management and staff is impressive. In a very short time an efficient and professional organization has been built up despite the absence of a nearby large science facility from which the project could have drawn expertise and methodology. The ESS team is highly qualified and motivated for pushing this project into its next phase. The main purpose of this report is to give advice on whether the ESS project is ready to proceed to construction and the report will focus on the future challenges and give recommendations on topics which the Panel thinks need particular attention.

Although Europe has been at the leading edge of neutron research for several decades with the provision of ILL and ISIS, it is clear, in line with the OECD recommendations of 1998 and various subsequent reviews, that it is now timely for a new world leading spallation source for Europe to be constructed. The ESS is in the fortunate position that both the US and Japan have taken spallation technology forward with SNS and J-Parc and this more recent experience can be built upon by the ESS.

That a new European machine is needed is obvious since structural, temporal and dynamic information is needed for many applications which will significantly affect the future quality of life for future citizens. There is always an element of doubt over the long term availability of ILL and ISIS with its two target stations which will eventually come to the end of its useful life. Current and future applications include the development of new energy storage systems, magnets for controlling machines, the impact of various materials on the environment and the safety of critical engineering structures to name a few. Whether large scale applications in biology and medicine come forward as in the case of synchrotron usage is far from clear at this stage but the ESS facility must be open for new unforeseen applications as they come along. It is also to be applauded that the ESS will be a European machine bringing together interested parties and users from a wide range of cultures and backgrounds that will enrich European society and specifically add to the cultural vigour of the Öresund region. Not only will it attract world leading scientists and engineers, the very intellectual energy will attract new industries building on the existing success of the Medicon Valley. Any future governance structure of ESS must reflect and encourage this culture of pushing the barriers of knowledge and there must be an acceptance of risk over and above that which is normal for construction projects. Scientists are not motivated by buildings or reports, but by making new discoveries ahead of anyone else. Management and support services need to recognise this while ensuring funders and taxpayers are satisfied that public funds are being used wisely. Above all, the transition from a purely Swedish-Danish owned company to one that is truly European should be congniscent of this in setting broad objectives and not interfering with the scientific programmes which should be left to normal international peer review processes.

Lund has a unique blend of history and modernity fostered by the links between the university and industry. The ESS needs to be integrated into this community as so many new ideas develop as a result of unplanned discussions between different parties. The siting of Max-IV alongside ESS is a fantastic opportunity for constructive engagement since scientists looking at problems will often be using both facilities. The example of ILL, ESRF and EMBL in Grenoble is an outstanding example of how the facilities can offer considerably more than the sum of their parts. Likewise at the SNS, co-locating specific laboratories alongside the facilities has shown how new areas can be fostered successfully.

Returning to the review, the Panel has been very impressed by the openness and frankness of the ESS project team. Their enthusiasm has carried them forward despite an uncertain future. A key decision will be the appointment of the new CEO who will need leadership qualities for dealing with stakeholders and staff alike. Also the person will need credibility among the world wide scientific community. This is a tall order but the panel feels that the CEO will be needed as part of the discussions to bring in further international partners and it is essential that this aspect is taken into consideration. Likewise the board of ESS AB will need to delegate powers to the CEO so he/she can deliver the very ambitious programme without constantly seeking board approval. With the transition from design update and costing to project execution it will be necessary that clearly defined roles, responsibilities, authorities, and accountabilities be developed between the ESS board, the International Steering Committee (STC), and the new CEO. This will require a high degree of trust amongst the parties combined with appropriate approval authorisation and oversight that recognize the need for a decision making process that is matched to the pace of a major construction process. Once policies and procedures are validated the ESS team will need to be able to act quickly within them.

The time line of the project is ambitious and the panel have looked critically at the need for finding the human capacity to deliver. All presenters indicated that attracting quality personnel was probably their biggest risk. Apart from some technological risks outlined below, the need to bring highly trained people in from all round the world quickly enough is likely to put the timeline under pressure. Scientists are seldom tempted purely by money and look at the working environment (including intellectual), facilities and the ability to pursue their ideas without undue bureaucracy. Likewise there is a considerable difference between the planning, construction and operation of a facility like ESS. The transition from one phase to another need to be thought through from the start. It is also very important to be able to meet the expectations from the scientific community and a project of this size can not afford to fail to deliver. Therefore it is wise for the ESS project to be expedient in what it promises at the start. Similar facilities elsewhere start with very modest performance specifications allowing components and instruments to be tested and checked before the full specification is achieved.

This report is intended to be a light touch one to look at the overall direction of the project. It took place over 2 days (May 31st – June 1st) at ESS headquarters in Lund, Sweden, 2012. The review team was provided with extensive background documentation in advance of the meeting - the most important being the Conceptual Design Report, Programme Plan, Costing Report as well as additional documents summarizing the various ESS development efforts. The Review Panel also heard several presentations by representatives of the project. Members of the ESS project team attended the presentations, and extensive discussions on points of particular interest occurred between members of the Panel and the project staff, both during the presentations and off-line during breaks in the presentations. In addition there were telephone discussions with the chairs of the SAC and TAC.

The review team are grateful for the work ESS put in for supplying all the relevant documentation and for the management and staff who made presentations.

2. Governance

The review team appreciate that the ESS AB legal entity was formed before receiving the final commitment to proceed with construction and was set-up, initially to deal with the pre-construction phase.

The overall governance and management of the project would appear to be effective, in principle but could be working more effectively in practice. The board together with the Steering Committee represent powerful supervising structures and their interaction needs serious consideration especially as other countries make financial commitments to the project. This assumes that some form of company structure continues to exist rather than going to the length of creating an inter-governmental agency. Thus there are two stages to be looked at, first the board as it now is, nominated by the Swedish and Danish governments, and secondly how it will evolve as other countries join and whether there are shares and rights to nominate directors.

The Panel feel that communication between the current board and the ESS management could be improved and that it seems to be a two-way problem caused by lack of mutual confidence. The ESS Management thinks there is an over demand of reporting to the board while the board regards the information from the management not to completely fulfil their requirements and expectations. Normally boards would not be involved in detailed management decisions and confusion in this area can lead to a lack of confidence in and a lack of morale in the senior management team. The review panel were amazed at the number of meetings each year that the board has had. Normal international standards would be for four a year with similar numbers of meetings for the steering group, and the science and technical advisory board with reporting lines between these following normal practices. It is clear that the highly influential (and potential new funders) in the steering must be effectively engaged in the preparatory phase otherwise there might be little enthusiasm for providing funds.

The current board would benefit from additional expertise in the field of international research infrastructures and this should be remedied as soon as possible. Research infrastructures are live facilities that must change with time and in scope if they are not to become expensive relics. By their very nature there will be areas where there is uncertainty in design since research during build is necessary to assess whether a suitable strategy will be successful. Likewise new ideas from the wider scientific community will evolve which have to be taken into account. It is clear that there are relatively few people who have knowledge of putting together such international research projects and it is highly advisable to co-opt this expertise, perhaps in the form of non-executive directors in the Board with different experiences from around the world.

The new CEO appointment is critical as the project moves from the pre-construction to the construction phase with its new demands. He/she will not have the time to take care of everything and clear levels of delegation need to be articulated. This is normally a management decision and the Board will need to know that there are normal checks and balances in place. The new CEO will have to have many qualities both externally and internally and will need the appropriate authority from the board to move quickly and deliver the facility.

Critical to the future is what type of legal entity the ESS will be. Should it remain a Swedish-Danish company as now which will have some advantages but certain issues such as tax, pension arrangements etc., might not be attractive for other countries to invest in, or an ERIC or similar organization with tax, employment and other issues already agreed at European level, or a full inter-governmental organization which will give greater freedom of operation but will take considerable amount of time to agree and set up. It would be expected that the Steering Committee must be critical in deciding the best model to consider. There is considerable experience among EIROFORUM and ERF members about the advantages and disadvantages of different solutions and many of the necessary legal documents are publicly available. It is clear that other governments will be reticent to become involved unless the way forward is clear. If funders are to be approached in the middle of 2013 resolving this issue is a matter of urgent priority.

3. Organization

The actual level of communication and interaction between staff, project leaders, contractors, and management seems to be sufficient in the pre-construction phase. However, it should be recognized that the future will bring growing demands and it is recommended that further attention should be given to internal communication as the numbers grow and construction begins.

The actual organization is mainly functional (Machine, Programme, Science, Administration) together with a component orientation (Accelerator, Target, etc.) within the Programme Directorate. The Panel notice that the interactions are running smoothly without problems in this growing entity. Nevertheless the organizational chart was perceived as somewhat confusing and not necessarily representing how the organization actually functions. This results from the complex interactions between the functional and component oriented entities. This kind of organizational structure demands a high degree of professionalism and flexibility based on a mutual vision and trust.

The move from an initial start-up phase to a large scale facility will need careful handling in terms of the need to deliver a project on time and on budget ensuring that new staff see the whole picture and be as motivated as the founders. This will need clear reporting and responsibility lines and the establishment of a more formalised cost function mapped onto the work breakdown structure serving both as an early warning and a counter steering system.

These duties will have to be executed by the new CEO as soon as possible. Currently the processes are running well depending on informal relationships. This culture needs to be encouraged in a problem-solving environment according to the future project demands.

The recruiting of the necessary human resources and also their integration into the running project could become a problem with respect to the ambitious schedule. The 200-350 high quality new staff needed presents a challenge, especially in engineering in the next two years. A recruiting strategy reflecting all important facts like long contracting times in a competitive environment, schooling, additional positions for a spouse, etc. should be sustained and its success should be continuously monitored.

4. Project Management

The Panel supports the decision bringing in external expertise using an industrial orientation. This helps the project to speed up with respect to management power, organizational structure and implementing necessary management processes and tools.

The project management structure as a whole under the responsibility of the Programme Director seems sufficient in the pre-construction phase. For future demands more cross-functions and/or staff under the control of the Programme Director seem necessary. The Programme Management for cost, time and quality control together with the additional cross-functions (Design Office, System Engineering & Configuration Management (Change Control)) has to be enlarged commensurate with the growth of the project. It should be considered whether this entity should act as a staff or as a line function with cross-functional accessibility to all component functions. This entity should work as a powerful planning, controlling and counter steering function in cases of deviations whether planned or unexpected.

The implemented management tools are appropriate for a project of this size and state of the art. Nevertheless the "right use" of these mighty tools (e.g. Primavera, ERP, MIS, etc.) together with the rightly set up internal processes has to be improved according to the future demands. The staff is committed and working well together, but a lot of work has to be done simultaneously. The planning and steering processes for cost and time aspects as well as for resources have to be implemented as bottom-up processes, addressing the single operational working group and using elaborated Work Break Down Structures with a time resolution of nearly a week. The data produced have to be automatically integrated in a Management Information System (MIS) and weekly/monthly updated. Similar complex processes have to be implemented to handle smaller and larger change and design requests, which often suddenly occur during the construction and assembly phase. All this will require extensive training and buy in by staff, many of whom will feel that these processes are an unnecessary distraction from building and operating the facility. Therefore they have to be embedded in the culture of the organization from the start but not be so heavy handed and bureaucratic to stifle the science mission of the organization

Special attention should be given on supplier management in future. The applied tools and processes should be implemented in the supplier management process as well as internally as far as possible. This should be the case also for in-kind contributions especially with respect to time, specifications and design (changes).

The current staff is highly motivated and brings in important expertise. Therefore the panel assumes that the existing and the future staff will probably make wide use of the existing tools and will implement the necessary project management processes right in time.

5. Technology

The Presentations covering the Accelerator Target and Neutron Scattering Systems summarized the current definition of scope and status of the design and cost estimate, on-going R&D and prototyping, process for selection of the final instrument suite, and areas of concern. This was supplemented by a telephone discussion with the Chair of the Technical Advisory Committee (TAC). In addition recent reports from the TAC were made available to the Committee for review. On the second day of the review there was a presentation and discussion of the status of the conventional facilities and architectural design, the status of target and moderator systems design, and project management.

Since the completion of the Conceptual Design Report (CDR) earlier this year work has continued to move towards a Technical Design Report which is intended to provide a basis for decision to proceed with ESS with a better developed cost estimate and schedule. Pending completion of the TDR we are able to offer observations on the rate of progress of the ESS project and the extent to which it will be ready for a decision next year.

The accelerator systems now have an updated technical basis with a high level parameter list that has stabilized around a specification that is robust and able to meet the overall ESS performance goals with a high degree of confidence. For the most part the key choices of the accelerator – superconducting cavities operating at 17-20 MeV/m accelerating gradient and the standard CERN frequency, one klystron per cavity, and two klystrons per modulator are conservative and do not represent significant extrapolations from proven performance. The one area with somewhat higher risk is the spoke cavities for lower beta but there is a prototyping activity underway which will mitigate that risk. This design should permit a cost estimate with good confidence level and moderate contingency. There is sufficient margin that the linac should have headroom for future upgrade or further optimization for cost reduction if that proves necessary and the additional risk deemed acceptable. The accelerator team has been adding qualified staff as new hires and secondees and this has helped accelerate progress.

The target is of greater concern, both to the review Panel and the TAC. The decision to operate at 14 Hz while retaining the 5 MW average power level exacerbates the demands on the target since by keeping average power fixed and reducing frequency the power per pulse is increased. 14 Hz has been adopted to balance the time period between pulses against the pulse duration. While desirable from an instrument design perspective a valid question to pose the instrumentation community is “is the lower repetition rate as desirable if the operating power scales with frequency” i.e. impose a target driven limit on power per pulse. This may turn out to be the case as detailed design of the target proceeds.

The project has adopted as a baseline design a He cooled rotating tungsten target which represents a first of a kind for a spallation target which, until now, have been either a stationary water cooled solid target or a circulating liquid metal target. The high power levels of the ESS have required an examination of alternative approaches and concerns about the possibility of runaway thermal behaviour above ~700 C with water and tungsten have driven the adoption of He cooling with water cooling as a backup. Selecting this option (with backup) is a reasonable basis for finalizing an update to the cost estimate however the relative novelty for this application implies that a higher contingency will be required in the estimate until the engineering design is further developed.

Having a sufficiently fleshed out design to support the TDR will require a more aggressive engineering effort than has been in place up to this point. In addition, it is important that the water-cooling option receive an equivalent level of effort in order to properly support a final decision on the target technology. The analysis of the two options should be sufficiently well developed to support the safety basis as well as provide an understanding of the neutronics, interfaces to instruments, operations and maintenance requirements, and conventional facilities interfaces. The present level of design does not support this comparison and it may require a prioritization for additional resources in the near term. If the conventional facilities design can be decoupled from this decision it will allow flexibility to be preserved. This appears to be the case if the base case is taken as He – a fallback to water will be possible within the same footprint. The reverse would not be true which does motivate the decision to take He cooling as base case. The focus until now has primarily been water vs. He cooling for a tungsten target – we recommend analysis of alternate target materials as an option, perhaps as a start-up, since that may be an acceptable fall back plan given the target is changed out regularly once the facility is operational.

The CDR has formed the basis for a program plan for the conventional facilities that will serve as valuable input to the design process. In addition to the planning around site function, flow, and layout there has been a significant focus on sustainability and energy use, which is a noteworthy feature of ESS planning. In the last year there have been additions to the staff that bring relevant commercial construction experience and project management that will be valuable as the transition to construction intensifies. The procurement for the Architect has begun via European tender and five firms will be contracted to prepare full proposals. Having this key contract in place will be essential to meeting the project schedule. It also represents a test of the rigor of procurement systems since it is a high visibility contract in an area where protests are not uncommon. The challenge in managing requirements on the facilities as a key component of cost control appears to be well understood by the team.

The site proximity to the future MAX-IV facility is an asset and was a component in the thinking behind the Lund siting decision in the first place. Although the two facilities have different funding and governance models they share closely related scientific user communities and some similarities in technology base, which should be leveraged for mutual benefit. Part of successful leverage lies in the planning for the facilities, their orientation and proximity, as well as possible opportunities for shared services where economies of scale may yield cost savings by pooling, in a transparent way, resources. The Lundamark location between the two sites should be viewed as a joint asset and there has been some effort to envisage how best to use it, perhaps following the model of the Partnership for Structural Biology in Grenoble. Although this is outside the scope of the ESS Project it is appropriate for ESS to attempt to catalyze such activities.

The final selection and design of instruments again depends on finalisation of the target layout and geometry. Currently the list of instruments seems conventional and they are likely to work effectively based on existing instruments elsewhere. While some conservatism is needed in the early days, decisions on more risky designs that will maximise the effectiveness of the machine are needed now since the necessary research and development will take longer before designs can be finalised. The panel feel that this aspect needs considerably more attention.

One aspect of procurement was of particular concern. Value for money does not mean the cheapest. The primary value element should be performance and reliability. Downtimes to replace key elements are incredibly costly, often far exceeding the original saving. In addition, any unexpected down time will affect the international confidence in the machine. There is competition elsewhere in the world and researchers will go for the best source wherever it is.

A final word needs to be said regarding the cost base of the TDR which links back to the management of the project. It has to be very clear what is included and what is not. For example are the research and development costs for new beam lines included or is it just the construction of the final design. Strict rules for the cost model and acceptance of in-kind contributions need to be agreed. How contingency is to be handled is always an issue. At the end of the day, funders will have a figure in mind for the real cost to them based on inflation etc. There are psychological limits and the project would be well advised not go beyond these and if necessary de-scope the project accordingly.

6. Recommendations

1. The Panel see that there are no significant reasons for the project not to proceed to construction.

2. The Panel commends the decision to form ESS-AB for the pre-construction phase but it is now urgent to decide (in conjunction with other potential funders) what would be the most appropriate vehicle for constructing and operating the ESS as a European facility. It would be worthwhile looking at how other European facilities are governed and the formation of an ERIC should be rigorously considered.

3. Consideration should be given to co-opting some non-executive directors onto the ESS-AB board who can bring experience of realising and operating international research infrastructures.

4. The panel understands that the appointment of a new CEO is nearly agreed. It is important that the interface between the board, CEO and the STC is clarified so that the construction phase can progress efficiently. This will require trust of all parties and sufficient delegated authority both to the CEO and other senior staff.

5. The new CEO should be part of the negotiating team with other potential funders.

6. The production of the TDR is urgently needed to describe what is and what is not included in the anticipated cost model. Attention should be paid to how the facility could be de-scoped if insufficient funds are not forthcoming. However there should be no compromise on the accelerator since this will be the most difficult and costly item to upgrade in the future.

7. There is a unique opportunity to optimise the outputs from the co-location of Max-IV and ESS by using the land between them to foster interactions and the possibility of sharing administrative and support services.

8. Training will be needed for new staff on "how we work together" to ensure construction is on time and on budget in order to avoid silos developing as the numbers increase.

9. The appropriate management tools already available need to be used effectively at all levels and a culture where this is owned by the staff (especially free thinking scientists) needs to be encouraged.

10. Critical components may need long lead times to obtain and need ordering as soon as possible.

11. It is unwise at this stage to concentrate on just one approach to the target. At least one alternative should be supported until it is obvious that the current proposal will work well.

12. Although tungsten will give the highest neutron flux, it will be advisable to start with a material that is less ambitious.

13. There is severe competition for high quality people with the appropriate skills to construct and run such facilities. The employment package must be sufficiently attractive and not merely reflect national benchmarks.

14. Handling and managing in-kind contributions is very difficult and clear rules of engagement for partners and suppliers need early articulation.

15. Internally implemented management processes should be applied to supplier management and in-kind contributions.

16. SAC and instrument scientists should be encouraged to bring ideas forward for instruments that will fully exploit the ESS when it reaches its full specification. Some of these should be selected for the first round of investments.

17. It is suggested that various scenarios (e.g. failure to attract sufficient staff, failure of a critical component) are “stress tested” to make sure the organization is robust to respond positively

Appendix 1

Issues and questions to address in the first review of the ESS project

<u>Compliance of the ESS Project towards its goals and Programme Plan</u>

Are the overall scientific and technical goals of the ESS project adequate?

Yes. The baseline configuration of the facility meets the expectations of the future evolution and needs for neutron beams as put forward in the OECD Megascience forum and the future evolvement of this. The science and technological goals have now converged in the Conceptual Design Report which is a major milestone for the project.

Will the project strategies and plans adequately lead to the world's leading facility for neutron scattering based science? Are there essential parts missing or less developed?

The Panel feels that more efforts should go into adapting the facility for new user groups not necessarily expert in neutron scattering. The future impact of e-science and a more innovative approach to data management should be undertaken from the beginning to allow remote access and the constructive re-use of publicly available data.

Is the overall time schedule realistic and is the project planning adequate for it?

The Panel believes the overall time schedule to be very aggressive but within reach. However, the recruitment of suitable staff and the buy in from other funders is a risk that might lead to time overrun.

Is the technical design of the ESS project sufficiently progressing to meet its performance expectations and to establish its technical, cost and schedule baseline in due time before Construction Phase?

The Panel regards the accelerator design as robust and appropriate to meet the ESS goals. According to the opinion of the Panel, the Target is of greater concern where alternative technology (target material and cooling) has to be maintained with the same priority as the decided baseline configuration. Attention should be given to more adventurous instrument design.

Are the project strategies, plans and actions leading towards the Construction Phase appropriate and complete?

At the present these are partially complete as would be expected in an evolving design. There is nothing of particular concern to stop the project proceeding to completion.

The governance and managerial status of the ESS Project

Is the overall governance and management of the project effective for its purpose in the Pre-construction Phase?

The establishment of ESS AB has been a key step in the realisation of the project. The appointment of a new CEO is going to be critical as the project moves from pre-construction to construction. The link and authority between the board and the International Steering Committee should be looked at again as other countries start to commit to the project.

The management of the project is in the hands of competent brought-in external expertise in project management. This has been a very effective way to implement “project thinking” into the programme where state-of-the-art management tools are to be used. The internal processes are running well.

Is the level of communication and interaction between staff, project leaders, contractors, management, board and stake holders adequate for a project at his stage?

The Panel felt communication could be improved between the board and the Project management. Part of this problem is because the organization has rapidly needed to evolve from campaigning into a (pre-) construction phase. Internal communication and with future partners was not investigated in detail but the panel noticed that the interactions seem to run smoothly without problems. Internal communication will become an increasing issue as construction starts.

Does the project communicate effectively with the various stakeholders, including the scientific community, funders, governments, local authorities industry, public?

The communication strategy has helped the project to establish ESS as a strong brand. Stake holders, local authorities and the general public are all covered in the strategies.

The Panel is pleased with the way the project interacts with the scientific community. Both the science symposia sponsored by the project, focusing on specific scientific areas, as well as the bi-annual IKON meetings were thought to be effective and appropriate ways to interact with the community – both existing and new. The Panel was particularly pleased to hear about the large number of young female scientist attending the last science symposium in Berlin.

What high level risks relating to the administration of ESS remain?

The ESS risk management is essentially governed by the Risk management plan and the risk management process. The Panel thinks the project has managed to include risk management as a continuous project and as an integral part of the day-to-day work. This methodology seems to have captured the most important risks at this stage.

The preparedness (or maturity) of the ESS Project for entering into the Construction Phase during 2013

Are the plans for the governance and management in the Construction Phase adequate?

The Panel encourages that the transition into a new governance structure be initiated as soon as possible. The ERIC structure seems to the Panel like a suitable framework for establishing ESS as an international facility but experience from other European facilities and development of an ERIC should be investigated. The stakeholders should aim for as large involvement as possible in the governing body of the new organization. Clear roles and responsibilities need proper articulation.

Supplier management will need special attention in the near future. Internally implemented management processes should be applied also to this. This should be the case also for in kind contributions especially with respect to time, specifications and design (changes).

Does the project have processes in place to ensure that the future needs of the scientific community are properly taken into account in the design and definition of the facility and especially the instruments?

The Panel thinks the SAC is involved in an appropriate way and that processes to involve and engage the scientific community has been developed. These seem to work well with established users of neutron facilities but need special attention for involving new user communities.

Is the project organization manned and designed properly for entering into the Construction Phase during 2013?

The key positions of directorates and divisions are appropriately manned for a project at this stage. However, the aggressive time plan of the project with a quick ramp-up of staff will be a challenge and implies a high recruitment rate. An area of particular concern is especially in engineering where the Panel see a real need to quickly increase staffing. The resources needed, in terms of volume and finding the right specialist will overall be hard to match. The Panel notes that all projects and sub-projects report about difficulties finding the right numbers of experienced staff. It is therefore necessary to be able to offer internationally competitive salaries and other employment conditions.

Are the roles and responsibilities properly defined within the ESS organization for entering into the Construction Phase during 2013?

Roles, responsibilities, authorities, and accountabilities needs to be even more clearly defined in the construction phase. This will require a high degree of trust amongst the parties combined with appropriate approval authorisation and oversight that recognize the need for a decision making process that is matched to the pace of a major construction process.

Are the procedures and plans for ESS quality assured enough for entering into the Construction Phase during 2013?

The project has a systematic approach towards quality management which seems appropriate at this stage. The panel did not have the time to study this in any great detail. The Panel regards the ESS framework project (EFP), which is to be integrated in the quality management system, as an important tool to further develop the ESS organization for the construction phase.

Is the plan for the conventional facilities sound enough for entering the Construction Phase?

The plan for conventional facilities is progressing and the process for choosing an architect for the design is underway. The site is undergoing archaeological investigations which will be followed by geotechnical investigations. The Panel urges the project to make every effort to share common facilities with MAX-IV which is to be located nearby. It is paramount that the facility is adapted to the needs of instrument and scientists who visit and not become an icon landmark. The sheer size of the facility means physical separation of the different scientific disciplines working at the facility. Therefore, care has to be taken to ensure suitable places for interaction amongst scientist. The Panel applauds the use of a common CAD system for both the machine and the conventional facilities.

Which major technical risks remain?

See above.

Is the R&D program sufficient to mitigate high-level technical risks?

The Panel strongly believes that WPs aimed at exploring alternative technical solutions for the Target should be initiated with the same priority as the baseline design. The target resources, staffing, and leadership will need to be focused in a more disciplined, engineering direction in order to keep pace with the balance of the project while resolving the remaining technical questions.

Are there other high level risks associated with the project?
See below.

Are there credible plans in place for resolving other remaining critical issues?

Planning for instruments has emphasized the development of a process for selecting individual instruments according to a schedule that extends to operating an eventual suite of 22 instruments included within the project scope. There has also been a significant effort in scientific community outreach based on a series of science-focused workshops coupled with more instrument focused IKON workshops. The project plans include a very aggressive 7 instruments online coincident with the first year of neutron operations. A simultaneous start-up of this many instruments has not been achieved at any neutron or x-ray source to our knowledge. Given the impact on early science planning for a robust start is warranted however given competing demands on project resources and the realities of detailed installation planning care should be taken in the management of expectations in the user community so as not to disappoint if the optimistic projection proves unachievable.

The outline of the peer review process has been developed but an open question is how this instrument definition and selection will be reconciled with in-kind contribution constraints. The desire to ensure appropriate standardization across the instrument suite is very important for both user friendliness and operational efficiency but may also come into conflict with the in-kind model unless requirements are clearly documented well in advance. Because of its impact on instrument selection and the risk that parochial posturing may cloud technical discussion it is important that the framework for managing the connection between facility wide instrument optimization with national contributions be finalized with the parties to the MOU as quickly as possible.

As noted in the target section the detailed configuration of the target moderator assembly has significant consequences on neutron beam extraction and instrument performance. This is another driver for a more engineering focused approach to the target design. The instrument groups have not received detailed guidance about geometric constraints and provisions for beam optics within the monolith and, as a result, are unable to develop a good understanding of instrument performance needed to inform the selection process. This does not impact the cost estimate activity since that is based on a reference suite of instruments that are understood to change as the instrument selection process unfolds. It will be important for proceeding with the project however.

Appendix 2

Terms of Reference

The European Spallation Source project aims to construct the project world's strongest accelerator neutron source in Lund, Sweden. It will be utilised for research on materials and molecules in many scientific disciplines, ranging from physics and biology to cultural heritage and engineering, and include strategic areas such as nano science, energy materials, pharmaceuticals, environment etc. The ESS facility will be a long pulse neutron source based on a 5MW linear proton accelerator, a heavy-metal target, and a suite of 22 instruments. The start of construction is planned for 2013 and the first neutron radiation is planned for 2019.

There are now 17 European Partner Countries involved in the Pre-construction Phase, which includes a technical design update of the ESS. The Pre-construction Phase, which is governed by a memorandum of understanding (MoU) between the Partner Countries, expires at the end of this year and the plan is then to move into the Construction Phase as soon as possible. The co-operation among the partners is currently governed by this non-committing MoU between the countries, but this is planned to change to a formal international agreement for the Construction and Operation Phases. The formal legal body for the ESS project is ESS AB, which is a Swedish company co-owned by the Swedish and Danish governments.

The steering committee and the board of ESS AB have decided to make an impartial review of the status of the ESS project and provide advice to decision-making. This review, which is the first of a series of regular reviews, should focus on the high level aspects of the project in order to enter into the Construction Phase in a successful way.

The overall objectives of the review are to assess:

- compliance of the ESS Project towards its goals and Programme Plan
- the governance and managerial status of the ESS Project
- the preparedness (or maturity) of the ESS Project for entering into the Construction Phase during 2013

Specific issues to address by the reviewers are listed in below.

This review should help the project to keep on track according to the goals, ensure important aspects are not overlooked, and suggest improvements to the various aspects being reviewed.

This review should be done during the first half of 2012. It is the first in what is intended to be series of reviews during the project life cycle.

The review group should have three to five independent, high-level experts with complementary competences and with different areas to focus upon - function (scientific/technical), management, and cost/timing.

The review will be based on:

- documentation provided by the ESS project
- a site visit in Lund, including short oral presentations

- discussions with ESS management and staff
- interviews with other key persons to the project

The documentation shall be ready in advance and will include, as a minimum;

- the ESS Conceptual Design Report, with an updated memo

- the latest version of the Programme Plan

The site visit is to be performed 31st May - 1st June at the ESS office in Lund.

The reviewers report will be delivered later in June.

Issues and questions to address in the first review of the ESS project

Compliance of the ESS Project towards its goals and Programme Plan

Are the overall scientific and technical goals of the ESS project adequate?

Will the project strategies and plans adequately lead to the world's leading facility for neutron scattering based science? Are there essential parts missing or less developed?

Is the overall time schedule realistic and is the project planning adequate for it?

Is the technical design of the ESS project sufficiently progressing to meet its performance expectations and to establish its technical, cost and schedule baseline in due time before Construction Phase?

Are the project strategies, plans and actions leading towards the Construction Phase appropriate and complete?

The governance and managerial status of the ESS Project

Is the overall governance and management of the project effective for its purpose in the Pre-construction Phase?

Is the level of communication and interaction between staff, project leaders, contractors, management, board and stake holders adequate for a project at his stage?

Does the project communicate effectively with the various stakeholders, including the scientific community, funders, governments, local authorities industry, public?

What high level risks relating to the administration of ESS remain?

The preparedness (or maturity) of the ESS Project for entering into the Construction Phase during 2013

Are the plans for the governance and management in the Construction Phase adequate?

Does the project have processes in place to ensure that the future needs of the scientific community are properly taken into account in the design and definition of the facility and especially the instruments?

Is the project organization manned and designed properly for entering into the Construction Phase during 2013?

Are the roles and responsibilities properly defined within the ESS organisation for entering into the Construction Phase during 2013?

Are the procedures and plans for ESS quality assured enough for entering into the Construction Phase during 2013?

Is the plan for the conventional facilities sound enough for entering the Construction Phase?

Are the plans and procedures for integration of the subsystems to the complete facility sound enough for entering the Construction Phase?

Which major technical risks remain?

Is the R&D program sufficient to mitigate high-level technical risks?

Are there other high level risks associated with the project?

Are there credible plans in place for resolving other remaining critical issues?

Appendix 3

Members of the Panel and affiliation

Prof. John Wood (chair), Secretary-General, Association of Commonwealth Universities, UK.

Professor Wood has both been an active academic researcher and worked in high level university management. He has acted as chair of the European Strategy Forum for Research Infrastructures (ESFRI) and of the European X-ray Free Electron Laser International Steering Committee. John Wood is also, among other things, advisor to the European Commission on large international research infrastructures. He was previously Chair of the UK CCLRC, which supervised ISIS and ILL.

Dr. Thom Mason, Director, Oak Ridge National Laboratory, USA.

Thom Mason was one of the three reviewers of the ESFRI review of the proposed ESS sites in 2008. He has during the last decade worked at Oak Ridge National Laboratory (ORNL), having been Director of the SNS for six years. In 2007 he became the Director of ORNL. He is an experimental condensed matter physicist by training and spent time in Risø as a senior scientist.

Dr. Wolfgang Meissner, Executive partner, In-tech GmbH, Germany.

Wolfgang Meissner has a wide background as an entrepreneur and consultant in the industry sector and with large-scale research projects, mainly focusing on management advice, organization, process optimisation and innovation management. He chaired the review in 2010 of the F4E Fusion for Energy which was the EU's agency for participation in the big ITER fusion reactor in Cadarache.

Dr. David Edvardsson (scientific secretary), Consultant, Sweden.

David Edvardsson has worked at Vetenskapsrådet (Swedish Research Council) since 2007, as a research officer, responsible for large-scale infrastructures in astronomy and sub-atomic physics. He is representing Sweden in the ESO Council and in the FAIR Council. Since 2010, he is one of ESO's delegates to the ALMA board. He has been scientific secretary for several large international reviews of research infrastructures.