STCC emails with regard to liquid lithium during Dec09
Copied as input to discussions in 2010

From: Richard P. Majeski [mailto:rmajeski@pppl.gov]
Sent: Tuesday, December 15, 2009 11:00 AM
To: Peng, Yueng Kay Martin
Cc: Steve Sabbagh; jmenard@pppl.gov; 'Raymond Fonck'; Baylor, Larry R.; 'Robert La Haye'; 'Kevin Tritz'; 'Jean Paul Allain'; Sontag, Aaron C.; 'Ahmed Hassanein'; 'Fred Levinton'; 'Steve Eckstrand'; 'Nirmol Podder'; 'Brian Lloyd'; Nelson, Brad E.; 'Yuichi Takase'
Subject: Re: New suggestions re: appendices - STCC document - FNS section the only major issue.

Hi Martin:

First of all I'd like to wish you a Merry Christmas, and with that suggest that we all take a much needed break from these discussions. I'm sure that we will revisit these issues in CY2010, with the next STCC assignment (whatever that might be).

But for now I need to catch up on my other (funded!) activities. And I, along with (I suspect) many others on the STCC, could use a respite.

Cheers,
Dick

On Dec 14, 2009, at 12:39 PM, Peng, Yueng Kay Martin wrote:

Dear Dick,

Thanks for the gracious forbearance shown with regard to this question of "unknown" vs. "H", for the liquid lithium PFC/PMI. I think I understand adequately of, and am very happy with, the depth and breadth of the knowledge and experience represented by you, JP, and Ahmed. Let's say that you are in this position of discussion has not been an accident.

I think we are at a place where there is a need to take stock of what science and technology we have attempted to cover in this extended discussion. So, please allow me to clarify the "stage" on which this discussion has thrived, but still relating to your email. Sorry as this repeats some of the earlier email discussions. I ask that you point out mistakes, misunderstanding, weaknesses in the following description:

1) With regard to the basis available to estimate the ratio of B/I (positive benefit/negative impact) for a future design whose mission is not to test and understand the principles of the LL PFCs, I would compare it with the strongest alternative so far: solid surface PFCs backed up by the cryopumps of the ITER design. This should be acceptable to all, since we are envisioning ST experimental embodiments in the ITER era.

2) It is appropriate to note that, for the ST embodiment to test and understand the principles of LL PFCs, the criteria for the basis for design are somewhat easier. The basis should be adequate to design practical and convincing components and systems for the purpose of experimentation, without needing to prejudge the outcome of the experiments. Further, the device design needs to be flexible to allow regular replacement of the test components and the operational capabilities, as we explore new grounds and discover the unexpected, with positive and negative outcomes equally possible.

3) Now, let's ask: what should be the required tests of the #2) ST for it to be acceptable to the #1) STs? Using the appendices of the white paper, we surmise the following:

a. Continuous (a few 100's s or longer) particle control using flowing LL surface over the range of, say, 70-90% in overall particle recycling coefficient. This is a crude guess based on the simple premises that 95% would be too close to the relatively well-known high recycling regime to make large or interesting enough differences on the properties of the toroidal plasma and the LL PFCs themselves. Any level near 50-60% or lower would lead to a requirement of nearly complete first wall coverage by flowing LL, and a very challenging core fueling requirement.

You have correctly pointed out the possibility of qualitative improvements in the core plasma confinement and stability, when the plasma overall recycling is strongly limited, a la Leonid's thesis. However, we are not equipped at this time to know the zeroth order design assumptions in confinement and stability for such conditions, as any large changes in these would lead to drastically better design space for the #1) STs, and Tokamaks for that matter.

We all know that this is a core mission of LTX. With such a huge potential "B", why is LTX funded as such an inadequate level for it to make the needed progress at the CE level in the next couple of years?

b. Continuous (a few 100's s or longer) high power and high heat flux handling using flowing LL surface over the range of ~20 MW/m2 and a total power of several 10s of MW. Here we assume that the reduced recycling and operating density for the #1) STs using a successful LL divertor system, which in turn puts about 2-3 times more plasma heat on the divertor compared to the high recycling regime.

4) Note that I proposed that the LL PFCs for #1) STs are to be compared with the ITER divertor design, with regard to the available design basis, not with any of the experimental tests today, as none appear to be studying the efficacy of the above two conditions. Let me count the ways:

a. LTX is an innovative CE experiment on the topic very low recycle toroidal plasma physics. Can the clever low cost design be readily extrapolated to the above two conditions a) and b)? You are the most knowledgeable judge of this, so please address this question.

A nearer term question: how should the present LTX design be changed so that the LL systems to be tested in LTX has a path of extrapolation to the NSTX-upgraded capability?

b. This question begs to be answered, since the present NSTX LLD and Li on C coating approaches in turn begs the question of: Can the present NSTX approaches be readily extended to the conditions a) and b) of #3)?

Similarly, how should the present NSTX design be changed so that it can be scaled to the LL systems to be tested in NSTX-upgrade, which in turn have a path of extrapolation to the PMI ST testing capability?

Jon, care to provide some insights to answering this question?

c. I am not familiar with the HT-7 tests, only somewhat familiar with the liquid metal limiter and capillary systems on FT-U and T-11 (?). I remember reading papers on some Russian concepts of large area toroidally continuous poloidal divertor concepts, either with open surface fast flow or with a capillary system. These papers argue the case for feasible application to high power fusion systems.

Why should the present experiments of this interesting approach stay at such a large scientific and technical gap from these concepts, if this is doable at the LTX, NSTX scales? What are the difficulties, the potential show stoppers, that prevented a serious research to address these concepts?

Could you, JP and Ahmed clarify the situation so that these questions can be answered at the level of science and technology basis?

With these questions answered this way, there is an increased chance to begin to clarify the design basis for the ST embodiments for high gain BP, FNS, and PMI test missions.

With an improved design basis, there is in turn an increased chance to begin to clarify both the "B" and "I" of the LL PFCs envisioned for ST and other fusion configurations.

These are a set of interlocking logical questions. I kind of believe that you were not overruled in your recommendation of "H" for the "P", but rather strengthened by a logical conclusion of "unknown". This of course depends on whether one chooses to define "P" roughly as a product of "U" and "(B/I)".

To be fair, I can cast the same logic to the ITER PFC design, and emerge with different and enabling conclusions. But that would be boring to many of us to warrant the time and effort at this time.

I look forward to learning your comments on the ideas in this rather long email, particularly where corrections and improvements are necessary.

Best regards,

- Martin

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Sent: Saturday, December 12, 2009 1:01 PM
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Cc: Steve Sabbagh; jmenard@pppl.gov; 'Raymond Fonck'; Baylor, Larry R.; 'Robert La Haye'; 'Kevin Tritz'; 'Jean Paul Allain'; Sontag, Aaron C.; 'Ahmed Hassanein'; 'Fred Levinton'; 'Steve Eckstrand'; 'Nirmol Podder'; 'Brian Lloyd'; Nelson, Brad E.; 'Yuichi Takase'
Subject: Re: New suggestions re: appendices - STCC document - FNS section the only major issue.

Martin:

I chose to step back from this argument because of my concern that it was distracting from the main task at hand, that of completing the white paper for Steve and Nirmol.

There are three members of this committee who have backgrounds in PMI, Ahmed Hassenein, Jean-Paul Allain, and myself - although I freely admit that I only began work in this area ten years ago, and most of my experience is with liquids. The same, of course, cannot be said of J-P and especially Ahmed, who is certainly a well-established leader in the field.

I am concerned that you chose to overrule all three of us, who were unanimous in disagreeing with you, in formulating an evaluation of the potential impact of liquid metal PFCs. What is the purpose of enlisting the help of experts in a field, if their views are ignored in formulating a committee report?

I have also answered the question you posed yesterday, below.

Dick

On Dec 11, 2009, at 4:07 PM, Peng, Yueng Kay Martin wrote:

Fair. Show me a set of design concepts based on data at the CE level for LL particle control and power handling system. Use as reference the case of solenoid-free or minimal solenoid startup to acceptable plasma target with rf assist. The latter case has barely enough basis to project to start up to 0.5-1.0 MA level in PMI, FNS.

Martin, my office is across the hall from a CE level experiment to demonstrate liquid lithium walls in an ST, with full particle control; LTX. Across the PPPL campus, there is a PoP-level ST which has just installed a partial liquid lithium divertor target to investigate particle control and

power handling, NSTX. CDX-U, with a fully toroidal lithium tray, was of course a CE-level experiment. There are extensively published results dealing with these experiments. Therefore, most of the devices, past and present, involved in the U.S. ST program, with which this white paper deals, were or are heavily involved with liquid metal wall experiments. Elsewhere, T11-M, with a lithium rail limiter, was a CE-level equivalent experiment. FTU (certainly a PoP equivalent device) has a lithium rail limiter which has functioned at rather high power density (described in multiple publications), and is designing a much more extensive toroidal limiter section, with slow replacement of the working fluid by capillary flow. HT-7 (which is of course a superconducting machine) has tried a liquid lithium tray limiter, and is presently performing experiments with a capillary system. I have also had fairly extensive discussions with Jiangang Li from ASIPP concerning future implementation of lithium PFCs on HT-7, eventually with slow replacement, and with an eye to EAST. This broad and rapidly expanding experimental base is completely at odds with your casting of liquid metal PFCs as a poorly explored fringe idea.

On the other hand, there is not a single device, anywhere in the world, which has installed and operated a super-X divertor, which you rated to have "high" potential benefit. This is not to say that I consider the super-X concept not to have high potential, just to highlight the arbitrary definition of "potential benefit" which seems to be employed in the white paper.

Solenoid free startup, and rf heating or current drive, has no relevance whatever to the question at hand.

Ramp up is a separate subject, let's don't get there for now.

- Martin

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From: Richard P. Majeski [mailto:rmajeski@pppl.gov]
Sent: Friday, December 11, 2009 3:50 PM
To: Peng, Yueng Kay Martin
Cc: Steve Sabbagh; jmenard@pppl.gov; 'Raymond Fonck'; Baylor, Larry R.; 'Robert La Haye'; 'Kevin Tritz'; 'Jean Paul Allain'; Sontag, Aaron C.; 'Ahmed Hassanein'; 'Fred Levinton'; 'Steve Eckstrand'; 'Nirmol Podder'; 'Brian Lloyd'; Nelson, Brad E.; 'Yuichi Takase'
Subject: Re: New suggestions re: appendices - STCC document - FNS section the only major issue.

Martin:

I would honestly appreciate a serious answer to the issue I raised.

I reiterate:

To stress my position, Martin - I completely agree that liquid metal PFCs merit a rating of high scientific uncertainty. But the potential benefit is widely recognized as high.

I would like to know on what basis you rated the potential benefit of LM PFCs, which of course includes less reactive metals such as gallium and tin, as "unknown".
It is otherwise quite difficult to answer your concerns.

Dick

On Dec 11, 2009, at 3:39 PM, Peng, Yueng Kay Martin wrote:

Dick,

Now we are talking science and techniques. Please check on LL pumps that are nuclear grade that involves tritium, impurities activated, etc. Also include MHD effects, plus those from plasma burps. Lithium cleansing in the loop too. Note that the only safety allowed heat transfer option would be He too. Some of the information is findable in the nuclear industrial component data.

For He systems, ITER is prototype testing its component designs. Based on such tests, we have basis to project to FNS, PMI, and BP concepts. It is challenging, but well based nevertheless.

Put down some quantitative requirements, then we at least approach the question of feasibility. Then the R&D needed for a feasible systems concept.

- Martin

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Subject: Re: New suggestions re: appendices - STCC document - FNS section the only major issue.

Martin:

My comment is very, very specific to the assignment of "unknown" to the potential benefit of liquid metal PFCs. This is a simple risk-benefit analysis, and is exactly aligned with the approach you took in constructing this table.

The scientific uncertainty ("risk") in liquid metals is certainly high. Everything you cite below is aligned with that assessment, and I agree.

The POTENTIAL "benefit" is also, quite clearly, very high. Nothing you say below even touches on this question.

This is your table, after all. But I am asking you to be consistent in implementing it.

And the answer to your question is 139 kg/sec, or around 4500 gpm. My Grainger catalog lists a pump which can handle 1200 gpm for $2600., and of course lithium has only half the viscosity of water. Lithium is chemically a bit nastier than water, of course, and this answer is a bit tongue-in-cheek. But I hope you can see the point.

By the way, this compares to a circulation requirement of only about 100 kg/sec of helium. But a kg is a heck of a lot of helium, and I can't seem to find a blower from Grainger which can handle 1.2 million ft^3/min of helium (at STP).

Dick

On Dec 11, 2009, at 1:56 PM, Peng, Yueng Kay Martin wrote:

Dick,

Thanks for a specific focused question, which we touched on before, but did not resolve for lack of attention and/or time. Here you offers a good chance to do so on this topic.

My technical judgment at present is that the scientific and technical basis for a working fast flowing, high heat flux, particle pumping liquid lithium divertor surface is far far below those for the design basis for ITER divertor and cryopumps. I could not find a complete conceptual design of the LL divertor including all the support systems for tritium recovery, heat and impurity removal, for the very high throughput of LL. (That is, for 100 MW, how many kg/s lithium needs to be re-circulated at a in-out temperature difference of 200 degrees C? We can make estimates later, if you want, unless such already exist.)

I will be happy to change that word if even the very preliminary estimates and publications would suggest that the application is feasible.

This situation is understandable, since there is about a 2+ orders of magnitude difference in the resources applied to these two option sets. It is the advocates job to come up with answers to such a basic question.

I look forward to reading technical information that would address this question, which has been raised during our discussions of the STCC.

Thanks again.

- Martin

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To: Peng, Yueng Kay Martin
Cc: Steve Sabbagh; jmenard@pppl.gov; 'Raymond Fonck'; Baylor, Larry R.; 'Robert La Haye'; 'Kevin Tritz'; 'Jean Paul Allain'; Sontag, Aaron C.; 'Ahmed Hassanein'; 'Fred Levinton'; 'Steve Eckstrand'; 'Nirmol Podder'; 'Brian Lloyd'; Nelson, Brad E.; 'Yuichi Takase'
Subject: Re: New suggestions re: appendices - STCC document - FNS section the only major issue.

Sorry, Martin. I admit to having lost track of this, in the attempt to finalize the 5 pager.

But I had somehow thought that we had evolved to the point where the FNS would have one appendix (like BP and PMI), and that would be appendix B.

One glaring problem with Appendix C, from my point of view, is that the **potential** benefit of liquid metal PFCs is listed as "unknown". An entire Fusion Technology program (ALPS) was targeted at liquid metal PFCs, because the potential benefits were perceived by the PFC community as very high, **IF** we could successfully employ them. The **value** of a functional LM wall was never in question within the PFC steering committee, just our **ability to build** a functional LM wall.

So I in fact agree with your assignment of "H" to the scientific uncertainty, but the Benefits/Impacts without doubt merit a "3".

J-P, who is also on the PFC Steering Committee, should weigh in too, if he has time.

I cite this issue as a single example, by the way, I haven't had the time I need to go over this carefully.

Dick

On Dec 11, 2009, at 11:57 AM, Peng, Yueng Kay Martin wrote:

Dick,

We certainly appreciate your views this morning about Appendix C's content, which has been sent to all first about 2 months ago and updated about 3 weeks ago with more description of the logic for choices of priorities. The need for this information basis for FNS was first introduced during our meeting in October at Madison. Please go to the STCC collaboration work site on the web to find the archives for these.

We, however, simply have progressed to finishing the final report today, and missed opportunities that were available during the past 2 months to improve the Appendices on BP, FNS, and PMI any further.

Nevertheless, we look forward to continue discussions within the STCC about PMI and BP embodiments and research needs, and of course answering any scientific and technical questions you may have about FNS. Let start that next week, if you desire.

I look forward to learning any feedback you may have on Section 4 in the next 2 hours or so, to allow the final report to be produced and sent to OFES on close of business today (5pm EDST).

The extra valuable efforts you applied during yesterday and early today, are much appreciated. We no longer have the luxury of any drastic changes to the structure of the report and remain credible. I hope you understand this situation.

- Martin

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From: Richard P. Majeski [mailto:rmajeski@pppl.gov]
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Subject: Re: New suggestions re: appendices - STCC document - FNS section the only major issue.

Martin, Steve, Jon, all:

At this point it seems as if the consensus is to retain the appendices, for the most part. But I would also advocate deleting appendix C. It seems, for the most part, to be a repeat of Appendix B, with the addition of the "research needed" and the priority columns.

Did we, as a committee, receive earlier input, and discuss, on these last two, important, columns? I'm sorry if I missed this input, but I don't recall seeing this table before.

I see a number of entries I am uncomfortable with, not the least of which is the methodology for the ranking (along with some of the rankings themselves - the **potential** benefits of liquid walls and low recycling have been discussed so exhaustively I don't see how they can possibly be "unknown").

But I agree with Steve - I don't see how we can possibly come to closure on this important topic in one day. Could we resolve to submit at a later date, after we have discussed it?

Dick

On Dec 11, 2009, at 9:06 AM, Steve Sabbagh wrote:

Hi Jon and Martin,

Jon - I agree with all that you say. You add additional support for this position, which is entirely meant to help the cause for FNS.

Re: the appendices - yes, I think that most are fine If we want to retain them. The only one that is not parallel in structure and has issues (the priority table, and certain statements made) is Appendix C on the FNS. It's also the second appendix on FNS, where the other missions only have one. While appendix C could be changed, and we could examine as a committee each line item, do we really need that now, at this late hour? One possible solution is to just drop it. There are other solutions, of course.

Thanks for the extended reply.

Steve

-----Original Message-----
From: Jonathan Menard <jmenard@pppl.gov>
Sent: Thursday, December 10, 2009 11:52 PM
To: Steven A. Sabbagh <sabbagh@pppl.gov>; 'Peng, Yueng Kay Martin' <pengym@ornl.gov>
Cc: 'Raymond Fonck' <rjfonck@wisc.edu>; 'Baylor, Larry R.' <baylorlr@ornl.gov>; 'Robert La Haye' <lahaye@fusion.gat.com>; 'Kevin Tritz' <ktritz@pppl.gov>; 'Jean Paul Allain' <allain@purdue.edu>; 'Sontag, Aaron C.' <sontagac@ornl.gov>; 'Ahmed Hassanein' <hassanein@purdue.edu>; 'Fred Levinton' <levinton@pppl.gov>; 'Steve Eckstrand' <steve.eckstrand@science.doe.gov>; 'Nirmol Podder' <nirmol.podder@science.doe.gov>; 'Brian Lloyd' <brian.lloyd@ukaea.org.uk>; 'Nelson, Brad E.' <nelsonbe@ornl.gov>; 'Yuichi Takase' <takase@k.u-tokyo.ac.jp>; 'Richard P. Majeski' <rmajeski@pppl.gov>
Subject: Re: New suggestions re: appendices - STCC document - FNS section the only major issue.

Some comments on this perpetual debate.

It will be unseemly to have an appendix element of a single dissenting view, when I myself have many issues with how the FNS stability requirements have been portrayed, but would articulate such concerns differently than Steve. Example:

I think Martin's premise is that with beta-N low enough, "fast" RWM and maybe DEF control may be avoidable, which is a potential simplification in design and operation. Of course this limitation, depending on physics, could rule out operation at high neutron wall loading, which is not attractive for an FNS mission.

And as Steve points out, RFA and RWM effects can become important even below the no wall limit, and this is an active area of research. Further, without profile control, the no-wall limit could end up being rather low (example - RS q profiles prone to forming ITBs triggering internal disruptions).

Attached DIII-D paper touches on this, i.e. bigger challenge to fully non-inductive ops might be strong coupling between core q-profile and flow shear, transport/ITB, and stability. At least they found a scenario (with high q95) that stuck around for several tau-CRs. Also points out the potential benefit of having a small transformer for tweaking Ip (which ST FNS won't have?). but beta is pretty low and would not support an FDF-based FNS scenario.

Anyway, we've pretty much completely ignored internal mode stability, which is also potentially dangerous. We simply assume NBI q control will be enough to avoid this and move on.

And at some point, at low enough beta, the supposed advantage of the ST disappears, since the TF electricity consumption gets comparable to higher-A tokamak but with added disadvantage of having no OH solenoid. This is one reason low beta is unattractive to me, and if the goal is to produce neutrons independent of overall device efficiency, that assumption and prioritization should be very clearly stated, since most people assume ST FNS goal is closer to original (PPCF 2005) ST-CTF design points which minimize power consumption.

As a group, we have never really discussed the profile control capabilities or requirements for an FNS (or in fairness, the other missions).

Is all we need shape/position, density, beta, and NBI-CD profile control of q, and that's it? (of course measuring q and rotation in real-time in nuclear environment is non-trivial).

With NSTX and MAST upgrades + tokamak program, assessing the disruption-free beta achievable with this level of control in fully non-inductive scenarios should be possible. I think Martin views such research as high priority, and I agree, and is probably something we can all agree on.

But this does not mean that active mode control research is low priority, since one cannot assess the value of active mode control without being able to test it. Also, advanced state-space controllers may be able to provide pretty good RWM control even with external EFC coils (which FNS WILL have). ITER may have to resort to this if in-vessel coils don't get installed. NSTX will test such controllers in the next 2 years. We might be able to have high(er) beta-n even with far away external coils.
Why not find out?

For Steve - as for the appendices pertaining to machines (LTX, NSTX, etc.), these were written at a point when there was no tool capability discussion in section 4, and we thought that info should be provided somewhere. I tend to think these are still useful, since they provide capabilities by facility, and in more detail than in section 4.

Glad this document is due tomorrow ;)

Jon

On Thu, 10 Dec 2009 18:28:09 -0500, Steven A. Sabbagh <sabbagh@pppl.gov> wrote:

Hi Martin, Dick, and STCC Colleagues,

I've now been able to get through the appendices again, in addition to Section 1 - 4 (specific comments sent earlier today).

In general, I only have specific, important issues with the FNS section (which I've mentioned before, but some key points haven't changed). See more on this below in this email. I also attach a summary of these concerns as a reminder (using the old version of the appendices).

Here is a list of suggestions - being as brief as possible:

1) General approach: As Dick suggests below, if you retain only the appendices for NSTX, Pegasus, LTX, MAST and Japanese program summaries, the document would be fine.

I do realize that STCC members have spent a good deal of time on appendices that would then be deleted (including Dick - who echoed the suggestion of deletion - see below), so I can understand the desire to retain them. For the BP and PMI missions, I'm fine with retaining the associated appendices.

2) Appendix A (on high gain BP mission), and D (on PMI mission): generally ok, and while not exactly parallel in structure, the one page length is fairly lightweight.

Only specific points here are: reduce jargon (as suggested by Rob La Haye) - so "e-transport" would be better as "electron thermal transport".

In the PMI section, the scope is 5 - 10 years, but the rest of the

document covers a 5 year timeframe.

3) Appendices pertaining to machines (LTX, NSTX, etc.)
(i) LTX: ok
(ii) NSTX (Appendix E, page 1): ok
(iii) NSTX (Appendix E, pages 2-3): generally ok. Many of the facets of
NSTX-U are not covered (only the brief mention on bottom of page 1)
However, adding more is probably not the way to go.

Are pages 2-3 really necessary, given Section 4? (no issue with keeping them, though).

(iv) MAST (appendix D) : ok
(v) Japanese STs (appendix E): ok

4) FNS Appendix B:
- the first table is ok, and I think useful to be retained.
- I see less value in the questions in the table "...ReNeW Thrust-16 research elements". You could delete this.

But, if you want to keep these questions, then even though it's not parallel in structure to BP and PMI missions, it's probably not going to lead to any key issues either (except for 4b and 4c).
- Element 4b Passive: This is not really a meaningful question. A better
question would be: "What levels of active control (plasma rotation, kinetic profiles, dynamic error field, mode stabilization, etc.) are needed?
- Element 4c: Resonant error field: The question is not really meaningful as stated. If the suggestion for "Passive" above is taken, you could just delete 4c and be covered.

5) FNS Appendix C: This is the most problematic for me. The easiest thing to
do here, with no loss of key information, is to delete this appendix.
(or, if desired we might be able to fix this with some more specific changes)

Why not simply avoid dissenting view? Isn't dissenting view a messy and
non-standard thing to do? Let's just solve the problem (easily - by deleting this appendix, or by accepting specific comments).

Some of the issues for all to consider re: Appendix C:

(i) it's not parallel in structure to the BP and PMI missions
(ii) As a group, the STCC did not hash out and agree upon the priority table given.
(iii) the priority grades here are confusing, because of the earlier priority grades in Section 4.
(iv) No such priority grades are given in the BP and PMI appendices
(v) Some of the "research needed to understand physics basis and project
to FNS" are really incorrect.

Consider - for example:

4b) Passive: (the column reads) "Update ITER database with ST data on
low disruptivity conditions removed from known stability limits
for HIHM plasmas"

??? I can't understand how this action gives us needed understanding of anything. How can we be asked to sign off on this?

(vi) Some of the questions (again) are not the ones to be asking - such
as "4c" - needs to be significantly re-written, or deleted.

(vii) In the comments following the table, some comments need to be changed. I can provide specific changes if you will accept them (please send WORD file format if so).

Let me first say, Martin, that you have changed some of the text in this
section to be more acceptable (e.g. some changes under 4 make it a bit better). However, key issues remain.

One example is (under 4): "By choosing plasma operating conditions far below all known stability limits for Stages I and II of a ST FNS operation..." - this statement is not supportable. Reasons:

- Without an equilibrium, you cannot say with assurance that any target
is far below stability limits, but
- assuming you can evaluate stability based on a few scalars, Stage II of
FNS is not far from all known stability limits (and may be above several).

At betaN = 3.8, q_cyl = 3.7, Ip = 8.2 MA, the li is most likely smaller than
NSTX. The elongation is higher, triangularity lower. All of these are in the
direction of reduces stability. If li is sufficiently low, global modes
might be unstable at any betaN. NTMs will most likely be unstable. RFA will
most likely be significant, even if this is below the no-wall limit (as
indicated by JET and DIII-D operation below the no-wall limit). The
NTMs and RFA can lead to mode locking and disruption. Of course, RWMs
will kill the plasma more quickly.

On top of this, we don't know if the plasma rotation profile will be
stabilizing or destabilizing to RWM and NTM. (references can be
provided).

That about covers it.

Final comment - I don't think it's impossible to clean up the FNS
appendices to make them more acceptable. I'm willing to help.

RSVP, and thanks,

Steve

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-----Original Message-----
From: Richard P. Majeski [mailto:rmajeski@pppl.gov]
Sent: Thursday, December 10, 2009 12:17 PM
To: Peng, Yueng Kay Martin; Steven A. Sabbagh
Cc: Raymond Fonck; Menard Jon; Baylor, Larry R.; Robert La Haye; Kevin
Tritz; Jean Paul Allain; Sontag, Aaron C.; Ahmed Hassanein; Fred
Levinton;
Steve Eckstrand; Nirmol Podder; Brian Lloyd; Nelson, Brad E.; Yuichi
Takase
Subject: Re: Specific suggestions re: appendices

Martin, Steve:

I would echo Steve's comments on the appendices. In my more extreme view, the only appendices we should definitely retain are the NSTX, Pegasus, LTX, MAST and Japanese program summaries; they are useful for reference. I'm not sure about anything else. One (but not the only) concern is that our intended readers will glance at the length of the appended material, and ignore it, along with the program summaries. Which of course are currently at the end of the appendix list, further down than most people are likely to read.

Dick

On Dec 9, 2009, at 7:21 PM, Steven A. Sabbagh wrote:

Hi Martin, and STCC colleagues,

I went ahead and made specific suggestions regarding the present appendices, just to be clear.

In many cases, I suggest to delete large portions of the appendices. Reasons include (i) simplicity, (ii) repetition of information from Section 4, (iii) statements that cannot be supported, (iv) statements of things that we didn't do as a group.

(iv) is an important point. A good example of this is the discussion that is mostly given on page 4 re: the way priorities were generated for the FNS mission. While we have spent a lot of time in this exercise, we never had this prioritization discussion, as a group, during this assigned task. We should not give the impression that we did, especially if individuals don't agree with statements made.

Of course, if sections are deleted, there's no need for specific changes. Please tell us of you want to retain the sections that I'm suggesting are contentious by my comments in the PDF file, so specific attention can be put toward those sections now, before it gets too late.

Thanks.

Steve

<Appendices-draft5-20091204-sas.pdf>

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