

IAA Study Group Status Report

Responsible Commission:

Commission III

Study Number and Title:

IAA SG 3.15 Long Term Space Propellant Depot

Short Study Description (repeat from Study Group Proposal):

Long term on-orbit storage of propellant is a key technology for future deep space exploration, this involves numerous technology requirements such as cryogenic propellant management, boil-off control, propellant supply and transfer on-orbit, etc. The study will promote and advance the future application of high energy propulsion in various space transportation systems, so that the objectives of future missions may be enhanced with a cost reduction.

Overall Goal:

Identify requirements, concepts and opportunities for future high energy propellant space depots, identify required key technologies and define the road map for this new capability.

Intermediate Goals:

Offer opportunities for cooperation among nations on international deep space exploration and utilization, motivate innovation, and foster deep space exploration activities. Identify, evaluate and characterize requirements and concepts for future long term space propellant depots in the 2020-2050 time frame. Both technical and economic aspects will be considered, and alternate scenarios established and discussed. High level findings and recommendations for the consideration of the global space community will be formulated.

Progress in past six months:

- The first meeting has been convened at the IAC Congress in Naples on Sep.30, 2012, with the following agenda:
 - 1) Welcome / Approval of the Agenda
 - 2) Study Introduction
 - 3) Introduction of each member and discussion on possible additional members.
 - 4) Appointment of Vice-chairs
 - 5) First round tables on ideas for the study
 - 6) Preliminary discussion on study content outline
 - 7) Proposed way forward
 - 8) Next meeting
 - 9) A.O.B

- The 2nd meeting has been convened at the IAA Spring Meeting in Paris on Mar.21, 2013, with the following agenda:
- 1) Welcome / Introduction of participants / Approval of the Agenda
 - 2) Update on IAA plans for the current Study Groups (*G.Reibaldi*)
 - 3) Review of Study Team Composition and discussion on possible additional members.
 - 4) Discussion on study content outline: finalisation
 - 5) Allocation of responsibilities for study content
 - 6) Proposed way forward: schedule and actions
 - 7) Next meeting
 - 8) A.O.B

After the 2nd meeting, the proposed content has been finalized. Allocation of responsibilities for study content is also completed. Schedule and actions in future are also made sure as following.

IAA has decided to present the preliminary findings of current Studies at the occasion of the Head of Space Agency Summit dedicated to Robotics and Human Space Exploration planned on the 9th of January 2014 in Washington.

Our SG should try to contribute at its best towards this goal.

In view of that, the following **deadlines** have been identified **for 2013**:

- **June 2013:**
 - Completion of the preliminary Draft report for discussion within SG. This report has to be prepared has collection of inputs for each chapter/paragraph, coordinated by each identified Book Captain. The Book Captains shall interact with the Chairmen and Secretary to assemble the draft within the deadline.
- **July 2013:**
 - Discussion of the Preliminary Draft to be held within a dedicated SG meeting or virtual forum.
 - 3-5 July, IAA “The Future of Space Exploration” Conference in Turin, possibility to held another SG meeting and present the status of the SG to the Conference audience to get feedback and possible increased participation to the SG team.
- **September 2013**
 - Consolidation of the complete Draft report within the SG
 - 23-27 September IAC 2013 in Beijing, Presentation of the status of the SG at the Commission 3 meeting
 - New Meeting of the SG.
- **October 2013**

- 25th October, Finalization of the Draft Report including all deliverables
- Send the Report to IAA

• **November 2013**

- IAA will synthesise the main part/recommendation of the report for inclusion in the HoA report
 - IAA discuss HoA report with Space Agencies
- The 3rd meeting has been convened at the 8th IAA Symposium on the Future of Space Exploration Meeting in Turin on July 4th, 2013 with a teleconference form. In this teleconference, we reviewed the status of activities of our study and discussed next step actions.

Before the 3rd meeting, a preliminary draft report was prepared.

After the 3rd meeting, some new inputs have been added. And we are organizing a face-to-face meeting in Beijing Sep.22th, and consolidating a complete draft report to discuss in Beijing.

We also create an online copy, so everyone can work on the current copy and we don't have multiple versions floating around. Multiple people can edit the document at the same time.

- The 4th meeting has been arranged at the occasion of IAC64 with the following agenda (a 53-page report has been finished):
- 1) Welcome / Approval of the Agenda
 - 2) Explain the current urgent objective for the Study Groups (G.Saccoccia, LU Yu)

The current urgent objective for the study group is to finalize a draft report about 25 pages on 25th October. We should focus on the conclusion and recommendation part, even though our report has already had 44 pages.

An abstract should be prepared for the Head of Agency Summit to be held in Washington DC on the 9th and 10th January 2014.

Mr.Saccoccia plans to go to the HOA summit.

- 3) Review of current study report and discuss (All, presented by WANG Xiaowei)

The current study report contains 44 pages, and prof.LU Yu have reported this study at the IAA COM III meeting on 21st and the Academy day on 22nd Sep. The participants discussed the presentation of this study.

Japanese experts also are needed to participate, and Mr.Saccoccia will ask for Mr.Reibaldi may find someone.

The discuss focus on the technologies and the Roadmap for the implementation.

For the section “*Fundament and Status of key technologies*”, the experiences from other nations, such as ESA, Russia and Indian are needed. Thus, the study members from these nations please add some content for this part.

The TRLs for the key technologies need to be list in a table clearly, and Andrea will finish this in the near future.

The international cooperation will not be discussed in the Part II and was changed to be the *Common interfaces and usability*.

Two kinds of depots (both storable and cryogenic) should be discussed in the report. Storable depot also can be set at GEO.

For the roadmap decision part, a step-by-step roadmap for the international technology level should be given.

4) Proposed way forward: schedule and actions (G.Saccoccia)

IAA has decided to present the preliminary findings of current Studies at the occasion of the Head of Space Agency Summit dedicated to Robotics and Human Space Exploration planned on the 9th of January 2014 in Washington.

Our SG should try to contribute at its best towards this goal in this year.

In view of that, the following **deadlines** have been identified:

- **October 2013**
 - o 25th October, Finalization of the Draft Report including all deliverables
 - o Send the Report to IAA

- **November 2013**
 - o IAA will synthesise the main part/recommendation of the report for inclusion in the HoA report
 - o IAA discuss HoA report with Space Agencies

Taking into account the feedback from the event in Washington, the Study Report will then be finalised in the end of 2014. And the schedule of 2014 was identified as following.

March 2014:

- Taking into account the feedback from the event in Washington, improve and complement the draft report
- New SG Meeting in Paris

July 2014:

- Intermediate meeting on the final report preparation

October 2014:

- Sufficient inputs from all the SG members
- Chapter captains wrap up all the inputs, and a preliminary final report will be completed by Chairs
- New SG Meeting in Toronto

End of 2014:

- Improve and complement the final report
- New SG Meeting in Paris
- Discuss and identify when to send the final Report to IAA for review

5) Next Actions

Each participant continues to contribute the inputs for the report.

Prepare an abstract of this study group for the HOA summit in Washington D. C.

Wrap up all the inputs and form a draft report of this study report with a preliminary part of “conclusion and recommendation” by 10th October.

- An abstract has been submitted to the Head of Agency Summit to be held in Washington DC on the 9th and 10th January 2014. Mr. Saccoccia presented the preliminary result of this study. The next meeting is planned in Paris March 2-14. Taking into account the feedback from the event in Washington, the draft report will be improved and complemented.
- A SG 3.15 short meeting has been arranged at the occasion of IAA spring meeting in Paris in March 2015, and some actions are decided in this meeting:
 - Send to the team the latest version report.
 - Select active members to be the captains of some sections which is still blank.
 - Send to our study schedule to the team to request the inputs from each member.
 - Before this Sep. meeting, the 1st draft report should be finished. The captains should push the process and wrap up all the inputs before end of Aug., then send the final Chapter draft report to chairs.
 - Hold a face-to-face meeting in Toronto and work on the 1st draft report.

- Right now, new inputs from members have been received, and the 1st draft report (about 150-page) is being prepared and will be discussed in Toronto.

The study team composition is listed as follows(listed in alphabetic order):

Appointment Accepted:

Chairs:

Giorgio Saccoccia

European Space Agency – The Netherlands

giorgio.saccoccia@esa.int

Lu Yu

China Academy of Launch Vehicle Technologies (CALT) – China

luy@spacechina.com

Address: No.1, Nan Da Hong Men Road Fengtai District, Beijing, China

P.O.Box: 9200-1 Beijing China, Zip Code: 100076

Tel: (8610)68355500

Fax: (8610)68351570

Secretary:

Xiaowei Wang

CALT – China

iaa_sg315@163.com

Address: No.1, Nan Da Hong Men Road Fengtai District, Beijing, China

P.O.Box: 9200-38 Beijing China, Zip Code: 100076

Tel: (8610)88520294

Fax: (8610)88531462

Members:

Dallas Bienhoff

USA

dallas.g.bienhoff@boeing.com, dbienhoff@cox.net

Davina Di Cara

European Space Agency – The Netherlands

davina.maria.di.cara@esa.int

Sandra Gonzalez Diaz

sandra@sandraglez.es

Hans E.W.Hoffmann

Germany

hans.e.w.hoffmann@t-online.de

SHEN Lin

CALT, China

tolinsh@sina.com

Appointment No Reply

Sebastien Bianchi

Air Liquide - France

sebastien.bianchi@airliquide.com

Christophe Bonhomme

CNES - France

christophe.bonhomme@cnes.fr

James Free

NASA (Glenn Research Center) – USA

james.m.free@nasa.gov

Dettlef Hueser

OHB Space Systems – Germany

detlev.hueser@ohb-system.de

Ivan Ilin

Ballistic centre of Keldysh Institute of Applied Mathematics, Russian Academy of Sciences – Russia

is.ilin@physics.msu.ru

Jim Keravala

Shackleton Energy – USA

jim.keravala@shackletonenergy.com

Guenter Langel

EADS/ASTRIUM – Germany

Guenter.Langel@astrium.eads.net

Jerrold W. Littles Jr

Director, Advanced Propulsion Program

Pratt & Whitney Rocketdyne – USA

555 Discovery Drive

Huntsville, AL 35806

Office: 256-922-2581

Jerrol.Littles@pwr.utc.com

Kevin Miller

Ball Aerospace – USA

Mob: +1 303 949 1758

klmiller@ball.com

Robert Mueller

NASA (Kennedy Space Center) – USA

rob.mueller@nasa.gov

S. Ramakrishnan

Vikram Sarabhai Space Centre (ISRO) - India

s_ramakrishnan@vssc.gov.in, ramkrish49@gmail.com

Bill Smith

Aerojet Corp. – USA

wws@rocket.com

Jeroen Van den Eynde

University of Southampton - United Kingdom

J.VanDenEynde@soton.ac.uk

Alan Wilhite

Georgia Institute of Technology – USA

wilhite@nianet.org

Andrea Boyd

andrea.boyd@spacegeneration.org

Website Study Information up to date? (Study Group Membership, Study Plan and Schedule):

The Group membership is on the website, pls update if anyone replies the appointment.

Issues requiring resolution? (recommend approach):

Because some of SG members had not reply the appointments, please send to them again to push this. Someone may forget this thing. Thanks.

Product Deliveries on Schedule? (If modified explain rationale):

Study Team Member Changes? (List any Study Team Members that you wish to discontinue, and provide names plus contact coordinates of any Members you wish to add on the second page of this Study Update form.) Note: Complete contact information including email, tel. and fax must be provided for all additions. Only Members with complete contact information will be listed and receive formal appointment letters from the IAA Secretariat.)

Some Changed.

Name of person providing Study Group Status (Study Group Chair or Co-Chair):

Status Report Date: Sep. 07 2014

Study Team Membership Changes

Effectivity Date: 2014-09-07

Discontinue:

Add:

Fatoumata Kebe

fatoumata.kebe@gmail.com