The Training Concept Status and Improvement Strategy for Flight Operation Team of KOMPSAT

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KMOC (Korea Aerospace Research Institute Mission Operation Center) has been successfully operating KOMPSAT-1 and KOMPSAT-2 over last 10 years. Due to the recent need arisen for the more systematic and efficient training system to produce well-trained and certified satellite operators, KMOC training program and certification course has been established, which comprises lectures and practical work(OJT). The lectures have been video recorded for much easier access and revision to the material for the trainees with the benefit of reducing the workload of the lecturers. Also the training program contents have been revised to meet the standards of ISO9001 Quality Management System in 2010.

The Multi-Mission Operation due to the future launch of KOMPSAT-5, KOMPSAT-3 is currently being discussed but the most difficult issue is how to securely supply operators with hands-on experience. Continuous effort for the development of the training system to meet this requirement has been made such as research on various education resources, devising educational simulator and development of better certification method.

Throughout this paper, I would like to discuss the future requirements and strategy for the improvement of KMOC training program with the consideration of the operation environment of KMOC through the review and evaluation of current KMOC training system and the case study of training system in overseas satellite operation organisations.

I.   Introduction

KMOC (**K**orea Aerospace Research Institute **M**ission **O**peration **C**enter) has been successfully operating KOMPSAT-1 and KOMPSAT-2 over last 10 years. The KOMPSAT-1 had been operated from 1999 to 2008 and the KOMPSAT-2 has being operated normally since the launch of 2006. The KOMPSAT-3 and KOMPSAT-5 will be launched this year in 2012 and this will lead to the real Multi-Mission Operation era. Due to the recent need arisen for the more systematic and efficient training system to produce well-trained and certified satellite operators, KMOC training program and certification course has been established, which comprises lectures and practical work(OJT). The lectures have been video recorded for much easier access and revision to the material for the trainees with the benefit of reducing the workload of the lecturers. Also the training program contents have been revised to meet the standards of ISO9001 Quality Management System in 2010. ISO 9001 is an internationally recognized standard for the definition and implementation of quality systems for the design, development, production, delivery and servicing of any type of product or service provided by one organization to another. Especially, section 6.2 describes the requirement of human resource management related to the training program. In the deployed ISO9001 Quality Management System we described the competence of each position in FOT, the training procedures including planning, execution, evaluation and certification procedures.

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II. Organization for KOMPSAT Operations

The Overall organization for KOMPSAT operations is shown in Figure 1. The FOT is responsible for normal operation. The FST including the PST(Payload Support Team) provides an additional technical support for space segment such as anomaly resolution while the GST(Ground Support Team) provides a technical support for ground segment.
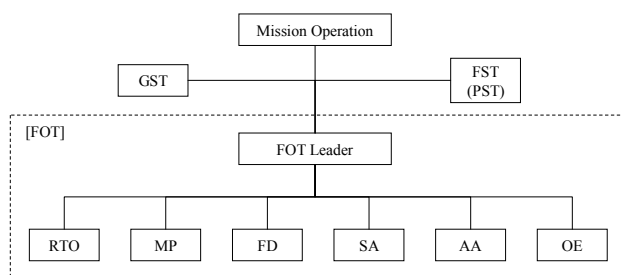

Figure 1. Overall organization for KOMPSAT operation

FOT Leader is responsible for overall operations and management within FOT. Real Time Operations (RTO) consists of Operation Controller(OC) and Command Operator(Op). The Op prepares a ground system for real time contact such as antenna scheduling, command preparation. And during a real time contact the Op uploads a command under direction of OC and monitors an uploading status. Mission Planning(MP) part comprises Mission Planner(MP) and Command Planner(CP). CP performs a role of generating and verifying a command based a defined procedure which is set up by Mission Planner. Flight Dynamics(FD) is responsible for orbit operation including orbit determination and prediction as well as orbit maneuvering. System Administration(SA) carrys out a role of maintenance of computer and network system. Antenna Administration(AA) is responsible for maintenance of antenna system including RF facilities. Operation Engineering(OE) performs a role of technical coordination between FOT and FST/GST.

According to the relevant position, each operator should have a proper skill suitable for stable operation through defining the required knowledge level. Table 1 shows the required knowledge according to the relevant part and position.

Table 1. Definition of required knowledge according to each position

Part	Position	Required Knowledge
Real-Time Operations	Operation Controller	-Overall technical understanding for KOMPSAT -Overall technical understanding of ground system
	Command Operator	-Basic understanding command/Telemetry operation -Basic understanding ground system operation
Mission Planning	Mission Planner	-Overall technical understanding of KOMPSAT -Operation alert and constraint of space/ground segment
	Command Planner	-Basic understanding of command operation -Basic understanding of operation alert/constraint
Flight Dynamics	Flight Dynamics Engineer	-Basic understanding of space/ground segment -Depth understanding of orbit operation
Ground System Administration	System Administrator	-Depth understanding of computer/network system -Basic understanding of KOMPSAT
	Antenna Administrator	-Depth understanding of antenna/RF system -Basic understanding of KOMPSAT
Operation Engineering	Operation Engineer	-Overall understanding of space/ground system

III. Training Concept for KOMPSAT Operations

A. Overall

KMOC continues to perform a training program since the KOMPSAT-1 operation preparation and has been making effort to evolve it including the training system improvement, the training material enhancement and the certification procedures, etc. KMOC should have performed a mission preparation for KOMPSAT-3 and 5 with limited staffs who also participates simultanuously in KOMPSAT-2 operations. It led to improve the KOMPSAT-2 training program for stable operation because K-2 mission was performed with the limited small staffs. So KMOC redefined the training program including training flow of KOMPSAT-2 and performed the training course according to the defined concept. Additionally, the all contents of lecture had been video-recorded for the reuse in a continuous training coruse such as recurrent training program. In 2010, we revised the training program to meet the standards of ISO9001 Qqulity Management System in 2010.

B. Key Requirement for Training Program

Ultimate training goal of KMOC is to reduce personnel errors and get into operation within less time with well-trained operator. Key requirement of training program to achieve this goal is as followings ;
- Develop a training plan including clear goal, expected results and schedules for completion
- Develp a skill and knowledge description for each position
- Review and update training plans periodically
- Maintain complete and accurate training and certification records
- Training should be in the form of Computer Based Training(CBT)
- Develop rehearsal and simulations
- Operators should take the training course of more than 16 hours per year.

C. Training Program

The training program for KOMPSAT-2 FOT consists of 22 subjects including lecture and hands-on training. Most of subject takes about two hours to complete. And it include mandatory, optional and part mandatory subject. The mandatory subject, which is yellow box in Figure 2, is the course that all operators complete. The optional subject, which is green box, is not mandatory course. The part mandatory subject, which is gray box, is that the relevant member of the part should take part in the relevant the hands-on training course. Therefore, total mandatory subject is eight subjects and the training program meets the requirement of 16 hours training per year.
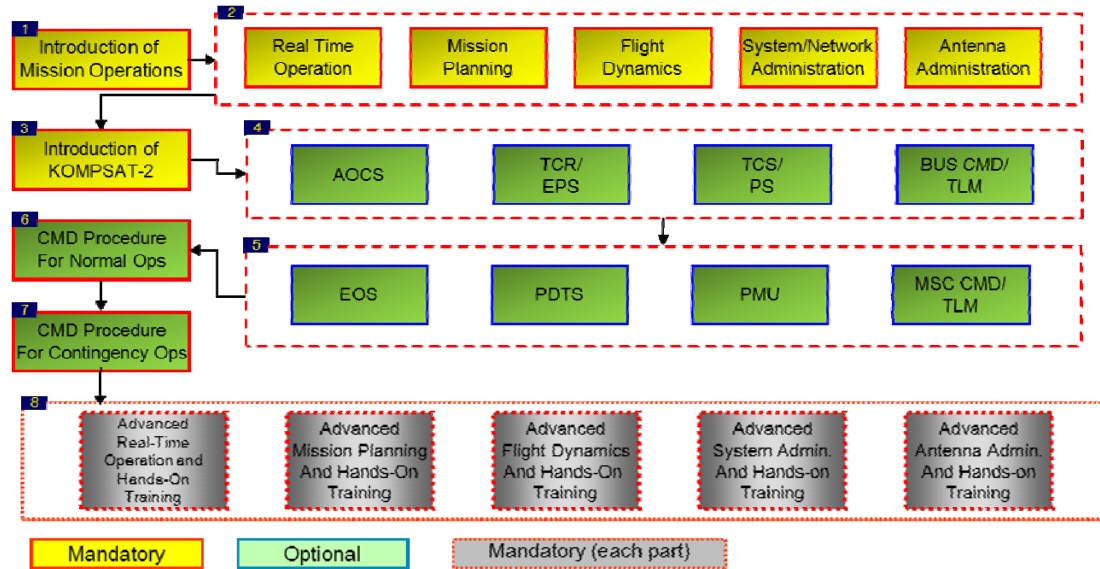

Figure 2. Training course flow for KOMPSAT-2 FOT

D. Resource management

We use several resources available to help train the FOT. The main resources are the flowing.

- Operation package including manual. It is useful of self-study and utilized as basic reference from new trainee to the senior operator.
- Lecture. It is performed by senior engineer or other expert to give additional information or to help trainee understand about technology or environment related to the operation
- Video-recorded file. All lectures are video-recorded to reutilize for continuous training. Most of senior engineers or other experts who participated in trining as lecturer are busy to operate the existing satellite or develop the next satellite. So video-recored file is used repeatedly to the trainees without interference to the lecturer. Fig x. shows the sample of video-recorded file that is generated and edited after lecture.
- Hands-on training. Practicing by himself/herself is very important factor in terms of training. A theoretical lecture has a limitation in a training course. The good balance between a theretical lecture and hands-on training is very helpful in efficiency of training program
- Simulator. It can be part of hands-on training to be performed as a way to practice operation procedure. Full dynamic simulator provides a way to practice nominal and contingency operation procedure without risk to space and ground segement. Unfortunately, KOMPSAT-2 FOT doesn't have a full dynamic simulator yet. So currently, our simulator is used for trainee to practice nominal command practice.

Figure 3. The sample of video-recorded file

E. Certification

For the training of new operator, certification management is performed throughtout the whole training course including hands-on training and lecture. During hands-on training and lecture, there are continuous questions by lecturer and answer by trainee. Lecturer can decide whether the trainee can catch up the training course and is ready to be certified through communicating with training officer continuously. The last certification is achived through the paper-based exam.

F. Recurrent training

Even after competion of certification, the continuous training should be provided to all staffs who participate in operations. The objective of recurrent training is to;

- Remind the critical and contingency procedurs. The critical and contingency procedures may be forgotten because it is not used freqently or even never. So these should be trained on a regular basis to insure the desired response by the FOT.
- Provide the new procedures and new systems. All FOT members should be familiar with them and share same operaions concept.
- To be cross-trained in other positions. To increase the efficiency of human power, FOT members need to have a multi-capability to perform a various position.

G. Training Concept based on ISO9001 QMS

ISO 9001 is an internationally recognised standard for the definition and implementation of quality systems for the design, development, production, delivery and servicing of any type of product or service provided by one organisation to another. ISO 9001 specifies requirements that determine what is called 'a quality system'. Especially, section 6.2 describes the requirement of human resource management related to the training program. The key requirement described in ISO9001 related to the training as the following.

The organization shall ;

- determine the necessary competence for personnel performing work affecting product quality,
- provide training or take other actions to satisfy these needs,
- evaluate the effectiveness of the actions taken,
- ensure that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the quality objectives, and
- maintain appropriate records of education, training, skills and experience

From the above requirement, the derived and deployed requirement into the 'QMS for KOMPSAT operations' is as the following.

KQM621010 Definition of competence
Operators performing work affecting product quality for requirement of QMS shall satisfy educational background, training, skill and experience suitable to the each position

KQM622020 Classification of training
Training officer shall plan and manage the following training course.
- QMS training : overall training for understanding the QMS
- Training of new operators : Training and certification of new operators
- Recurrent training : periodic training of the existing operators

KQM622040 Planning the training program
Training officer shall plan the training course for new operators considering the work in charge and experience.

KQM622050 Maintaining the records of the performed training course
Training officer shall record the contents of training course performed. If required, he is responsible for performing the improvement activity through the record of the needed improvement and the application of the follow-up actions.

KQM622060 Certification
Training officer shall verify the necessary competence through the appropriate certification procedures.

KQM622070 Planning the recurrent training program
Training officer shall plan the recurrent training program according to the 'The procedure for training" and determine through the review of each part leader and the approval of FOT leader.

KQM622090 Maintaining the record of personnel training history
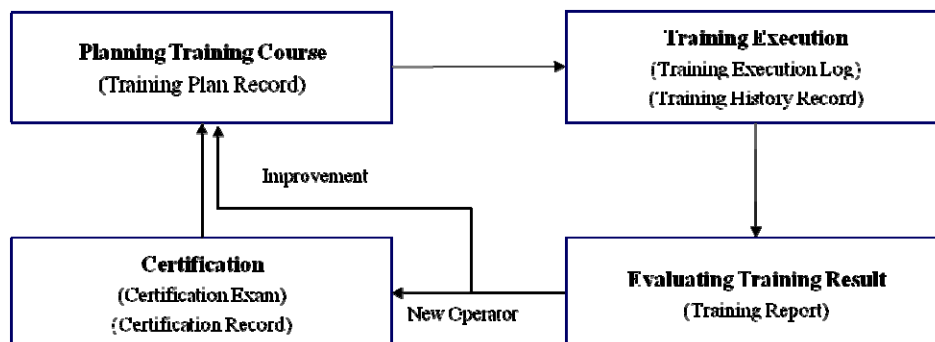Training officer shall maintain the record of personnel training history.

Figure 4. Training and Certification Procedure

IV. Improvement strategy

KMOC has been making effort continuously to improve training program for stable operation. There are a lot of thing that we have yet to implement. Two items out of them is to develop the simulator to be fully utilized in training program and to implement the dedicated training room.

A. Training Simulator Development Plan

In terms of training program, the simulator carries out a very important role as operators are able to practice a nominal and abnormal situation in real environment without risk of space and ground segment under operation. KMOC also has a simulator, but its function is not enough to utilize in training course. In case of KOMPSAT-2 simulator, it provides the very limited function such as command protocol verification. KOMPSAT-3/5 simulator provides the enhanced function through the full emulation of on-board computer while it doesn't have full dynamic simulation such as attitude, power and thermal modeling.

KMOC continue to make an effort to develop the training simulator which can be utilized during training program. Figure 5 shows the conceptual diagram of training simulator. Basically, simulator comprises server-client architecture. Client can be trainees, simulator administrator or training supervisor. Training course is classified into new operator training, recurrent training and the emergency recovery training. The main contents of new operator training course are normal and anomaly operation practice and it includes certification after training course is completed. The recurrent training course is for the existing FOT members and its training goal is to preserve competence and to refresh non-routine procedure. The emergency recovery training is for the FOT and FST(Flight Support Team) who provides a technical support and its training goal is to preserve competence of recovery procedure from contingency mode of satellite.
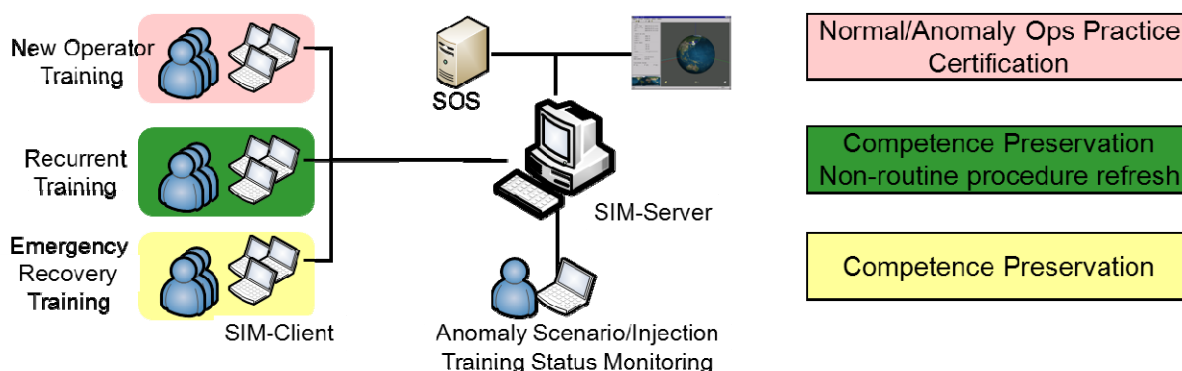

Figure 5. Conceptual diagram of training simulator

B. Training room development plan

Currently, KMOC doesn't have a dedicated training room which can be used for new and the existing FOT members. So most of hands-on training using simulator and Mission Control System(MCS is performed in the main control room. It leads to interference with normal operations sometimes and potential risk toward the system under the real operational phase.

To resolve this problem, KMOC plans to develop a training room with the training simulator, general Mission Control System, voice intercom and projector, etc. The training simulator is connected in the training room and also in the main Control room remotely. In case of being connected in the training room, trainees shall be able to practice the general MCT located in the training room under the training officer's control. Training officer shall be able to monitor the trainee's activity, evaluate training progress and inject some anomaly situation to see if trainee can respond to the unexpected scenarios.

V. Summary and future plan

Due to the recent need arisen for the more systematic and efficient training system to produce well-trained and certified satellite operators, KMOC training program and certification course has been established, which comprises lectures and practical work(OJT). The established training program comprises seventeen lectures and five hands-on subjects, i.e. totally twenty-two subject. The lectures have been video recorded for much easier access and revision to the material for the trainees with the benefit of reducing the workload of the lecturers. Also the training program contents have been revised to meet the standards of ISO9001 Quality Management

System in 2010. In the deployed ISO9001 Quality Management System we described the competence of each position in FOT, the training procedures including planning/execution/evaluation and certification procedures.

To securely supply operators with hands-on experience and to deal with the multi-mission operation era due to the future launch of KOMPSAT-5 and KOMPSAT-3, KMOC completed the conceptual design for the training simulator development and the dedicated training room development. Based on this conceptual design, KMOC plans to develop the training simulator and control room by the end of 2013. Simultaneously, we continue to research on various education resources, development of better certification method.

References

[1] "ISO 9001:2008 requirement", ISO

[2] "Quality Management System for KOMPSAT-2 Operation", 2010, K2MO-QM-9001

[3] David Fuller, "Satellite Mission Operations Best Practice:Training and Certification", 2003, AIAA