SAFETY TRIP REPORT

ON US-JAPAN EXCHANGE PROGRAM

(FuY 2007)

Report on the 12th Meeting of the Joint Working Group of the U.S.-Japan Coordinating Committee of Fusion Energy on Safety in Inter-Institutional Collaborations

(U.S.-Japan Safety Monitoring Program)

Meeting in Japan, March 9-22, 2008

A. PURPOSE

The purpose of the 12th meeting of the U.S.-Japan Safety Monitor Joint Working Group was to informally evaluate the programmatic aspects of environmental, health and safety (ESH) programs in Japanese fusion research facilities by touring laboratory areas and meeting with researchers and safety professionals. Based on these interactions, the U.S.-Japan delegation was able to share information and provide suggestions in an effort to reduce the likelihood of bodily injury and/or property damage. In addition, good approaches and practices developed at different institutions should be utilized to improve environmental, health and safety programs at other institutions.

B. EXECUTIVE SUMMARY

The U.S. participants in the 12th meeting of the U.S.-Japan Safety Monitor Joint Working Group conducted from March 9-22, 2008 were:

Richard Savercool, Fusion Safety Manager, General Atomics (3/9 – 3/22)
Keith Rule, Senior Program Engineer, Princeton Plasma Physics Lab (3/9 - 3/22)
Lee Cadwallader, Fusion Safety Analyst/Advisor, Idaho National Lab (3/9 – 3/15)

The main Japanese Participants were:

Dr. Yuichi Takase (University of Tokyo)
Dr. Yousuke Nakashima (University of Tsukuba)
Dr. Mamiko Sasao (Tohoku University)
Dr. Takashi Maekawa (Kyoto University - Yoshida Campus)
Dr. Hiroyuki Okada (Kyoto University - Uji Campus)
Dr. Hideki Zushi (Kyushu University)
Dr. Takayoshi Norimatsu (Osaka University)
Dr. Akio Komori (NIFS)
Dr. Masayasu Sato (JAEA)

The Safety Monitor Tour is an exchange of information between U.S. and Japanese fusion researchers to review personnel safety at fusion experiments operated in each country. This work is part of U.S. Department of Energy exchanges; the tour is listed in the DOE Coordinating Committee of Fusion Energy (CCFE) version 27-10, the safety monitoring tour for the U.S.-Japan Cooperation. Every two years a tour is conducted where safety professionals walk through fusion facilities and review the safety precautions at the selected facilities. In February 2006, the Japanese contingent came to the US and the US contingent visited Japan in March 2008.

Overall impressions of the labs and universities were very good. After the previous U.S. visit in February 2004, the major Japanese universities were incorporated into the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT). One result of this change was that the major universities are now subject to Japan national rules for occupational and industrial safety. Some of the professors stated that compliance with some of the national laws and rules was expensive, but overall we noted the facilities were cleaner, less cluttered, and tools were better organized. There was better attention to gas cylinder safety, more safety signs were in use, and more attention to general industrial safety than in past visits. As always, the facilities with larger annual operating budgets tend to have more safety provisions. It is a well known, but not quantified, safety principle that well-run, safe facilities are cleaner, more productive, and more efficient than facilities that do not practice safety.

There were many port covers and flanged openings at all of the facilities we visited however, few were designated or labeled as confined spaces. In addition several facilities did not have a formal program for personnel entry into these spaces. Confined spaces may be encountered in virtually any occupation; therefore, their recognition is the first step in preventing fatalities. Since deaths in confined spaces often occur because the atmosphere is oxygen-deficient, toxic or combustible, confined spaces that contain or have the potential to contain a serious atmospheric hazard should be classified as Permit-required confined spaces and should be tested prior to entry and continually monitored. We would like to suggest that the facilities consider using some form of the U.S. Occupational Safety and Health Administration (OSHA) regulations with regard to confined spaces. The following web link can be used to obtain information and resources: http://www.osha.gov/SLTC/confinedspaces/recognition.html

We would also like to provide information in regard to the U.S. fall protection programs. In the U.S. all fall protection products fit into four functional categories:

1. Fall Arrest
2. Positioning
3. Suspension
4. Retrieval.

A fall arrest system is required if any risk exists that a worker may fall from an elevated position. As a general rule, the fall arrest system should be used anytime a working height of six feet or more is reached. A full-body harness with a shock-absorbing lanyard or a retractable lifeline is the only product recommended. A full-body harness distributes the forces throughout the body, and the shock-absorbing lanyard decreases the total fall arresting forces.

A positioning system holds the worker in place while keeping his/her hands free to work. Whenever the worker leans back, the system is activated. However, the personal positioning system is not specifically designed for fall arrest purposes.

Suspension systems lowers and supports the worker while allowing a hands-free work environment, and is widely used in window washing and painting industries.

Retrieval Preplanning for retrieval in the event of a fall should be taken into consideration when developing a proactive fall management program.

We suggest the following web links for more specific guidance:

http://www.osha.gov/Region7/fallprotection/fall_protection_info.html
http://www.hfes.org/web/hfesnews/fallarrestsizing.pdf

The U.S. visitors also noted that there have been several new machines built and operated since the 2004 visit. These new machines indicate not only a healthy research program but also the need to continue performing these safety walkthrough tours.

The U.S. safety personnel making this trip were Lee Cadwallader from the INL Fusion Safety Program, Rick Savercool, the Fusion Safety Manager of the DIII-D fusion experiment operated by General Atomics in San Diego, California, and Keith Rule, a Senior Program Engineer from the Princeton Plasma Physics Laboratory in New Jersey. The U.S. trip itinerary is listed in section E.

C. Sites Visited

March 10, 2008 – University of Tokyo (Kashiwa Campus)

Contacts:

Dr. Yuichi Takase, University of Tokyo
Dr. Yasushi Ono, University of Tokyo
Dr. Zensho Yoshida, University of Tokyo

US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)
Lee Cadwallader (INL)

TST-2

Dr. Takase briefed us on the happenings since our 2004 visit when the Tokyo Spherical Tokamak-2 (TST-2) machine was sited at the in-town Hongo campus. When we last visited in 2004, the Kashiwa campus was under construction. Now, the Kashiwa campus outside of Tokyo holds the Graduate School of Frontier Sciences, the Institute of Solid State Physics, the Institute of Cosmic Ray Research, and a few smaller research centers. The TST-2 had moved to Kyushu University in March 2005 while its original Hongo campus building was being renovated. TST-2 was used at Kyushu until the Kashiwa campus was completed and then it was moved to its new home at Kashiwa late last year. At Kyushu University they have high power microwave (200 kW at 8.2 GHz) sources, so that electron Bernstein wave heating and plasma start-up were investigated using these sources while the TST-2 sojourned at Kyushu. Normal investigations with the TST-2 focus on ECH plasma start-up with the more modest power (5 kW at 2.45 GHz) available, as well as plasma heating by the high harmonic fast wave (400 kW at 21 MHz). The Kashiwa campus is new, large and the professors are rightfully proud of it.

There are not many visiting researchers or students, perhaps only one person per machine of the three fusion machines at Kashiwa campus. Visits can be a few weeks to a year. Short term visitors (weeks) and long term visitors take a safety training lecture class rather than computer based training. Brief visitors (~a day) are continuously escorted. The University of Tokyo does not have a refresher safety class requirement but they perform annual training for students working on fusion experiments. Each machine has safety inspections performed by university safety personnel (6 times a year, on average). The university safety manual for Kashiwa Campus has been translated into English in 2004 and it has been updated to reflect the new building and the new campus environment.

The lab housing TST-2 is called the Takase-Ejiri Laboratory. Dr. Ejiri is an associate professor working with Dr. Takase. All three machines we visited are housed in the Transdisciplinary Science Laboratory Building of the Graduate School of Frontier Sciences. The building has a personnel status board at the main door, where persons indicate their presence in the building by moving colored magnets next to their names. Dr. Takase admitted that this system is not working perfectly because sometimes people forget to move their magnets. There is a public address microphone near the main door to give emergency instructions as well.

- The TST-2 machine major radius is 0.38 m, minor radius is 0.25 m, and the maximum magnetic field is 0.3 Tesla. The control room has pertinent safety equipment, hard hats, flashlights, fire extinguishers. An emergency stop button is mounted on the wall next to the main door to the experiment. There is a telephone list mounted on the wall near the telephone but there is a microwave oven partially blocking the list, and the calling list is in Japanese. The TST-2 is new to the room housing it, and some work is still needed to enhance safety in the room. The room doors are locked but not marked. The doors are not interlocked, so anyone with a key could open a door from the outside (e.g., maintenance or custodial employee) and enter the room. Any person entering would not know if the machine is operating. There is a camera to monitor part of the experiment room from the control room but the screen is not watched on a continuous basis. The large exterior doors that allow deliveries are not marked, neither inside nor outside. The door locks must be turned to unbolt the doors to open them from inside; some of the doors may be configured to unlock from inside when the door handle is grasped and turned. There are no “crash bars” to unlock doors from the inside as specified in the U.S. Life Safety Code (NFPA 101) for personnel evacuation. Not all fire exits are marked, more exit signs are needed in the room. Some of the equipment in the room, transformers and power supplies, are very tall and would block emergency lights or cast shadows on egress paths if normal electrical power fails and personnel must evacuate the room.

The space around the experiment is free of clutter. Gas cylinders are properly secured. Some Bayard-Alpert vacuum gauges have protective covers around them, some do not. There are some loose tools in work areas close to the machine but the magnet fringe field (typically ~1% of the field at the plasma for a tokamak) is small at an estimated 0.003 Tesla (30 Gauss) so there is no concern about ferromagnetic missiles being drawn to the magnet set.

Issues called to the attention to the lab staff:

- Please post appropriate signs, international pictograms for exits and for hazards, including magnetic fields.
- Please mark the emergency stop button with English as well as Japanese.
- Please translate the emergency calling plan near the telephone or provide directions for non-Japanese visitors to call for emergency assistance (e.g., dial 119).
- Please post appropriate signs on exterior doors to inform persons of the experiment
- Please review all signs and placards for applicability and remove those that do not apply to the TST-2 laboratory

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UTST

The second machine we visited is the University of Tokyo Spherical Tokamak (UTST). The UTST is a new machine, it had first plasma at the end of 2006. The UTST machine was conceived and designed by using data from the high beta plasma created by plasma merging in the TS-3 and TS-4 machines, combined with data from the TST-2 machine. The UTST machine has a major radius of 0.39 m, a minor radius of 0.24 m, and a toroidal field on axis of 0.3 Tesla. Dr. Yasushi Ono gave us a brief description of this machine. At the time of our visit, the machine was undergoing modifications, adding a neutral beam injector and more capacitor banks. Several workmen were active in the room. The workmen were not wearing helmets or work boots but they were clearly part of a technical construction team. The machine was in construction, so it is not possible to judge how the machine is operated. Dr. Ono told us that the doors are not interlocked but they are locked, and the main entryway to the machine hall is through the control room (like the TST-2). No one is allowed inside the machine hall during experiment operations since there are several charged capacitor banks and other live equipment. The UTST is using a few international pictogram symbols for safety, but most of the warning signs are written in Japanese.

Issues called to the attention to the lab staff:

- Please post appropriate signs, international pictograms for exits and for hazards.
- Please post appropriate signs on exterior doors to inform persons of the experiment.

RT-1

The third machine we visited on March 10 was the Ring Trap-1 (RT-1) machine, which is a levitated dipole experiment. RT-1 confines a high beta plasma by using a dipole field and fast rotation. The magnet is mechanically lifted into place within the machine and levitates by magnetic field. Plasma pulses are 1-second duration. Dr. Zensho Yoshida briefed us on the machine, which had first plasma in January 2006. The RT-1 has a cylindrical vacuum chamber that is 1 m radius and 0.56 m tall. The ring magnet inside the machine draws 250 kA and weighs 110 kg.

Like the other machines, the RT-1 has a personnel status board at the main entry door to the experiment hall from the control room. Visitors are always escorted in the experiment hall. Like the other two experiments, the doors are not well marked and anyone with a key could open the door and enter – there is no good indication in the experiment room that the machine is operating. One door to the experiment hall opens to the main building foyer.

Issues called to the attention to the lab staff:

- Please post appropriate signs, international pictograms for exits and for hazards.
- Please post appropriate signs on exterior doors to inform persons of the experiment.
- Please use cord protectors for cords that cross walkways and aisles around the machine and for the cords on the floor from the control room to the machine.

March 11 – University of Tsukuba

Contacts:

Dr. Makoto Ichimura, Tsukuba University
Dr. Yousuke Nakashima, Tsukuba University
Dr. Tsuyoshi Kariya, Tsukuba University

US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)
Lee Cadwallader (INL)

GAMMA-10

Dr. Makoto Ichimura greeted us and opened our visit to the GAMMA-10 machine. The GAMMA-10 is a large machine, about 30 meters long. It uses electron cyclotron, ion cyclotron and neutral beam heating; fueling is by gas puffing and pellet injection. This is a very large machine for a university, and it has a large staff. There are 15 researchers, 6 technical staff, 2 office staff and 37 students working on the machine. They have memorandums of understanding with several countries, including Russia, Korea, China, Australia, and the US. They had 68 visiting researchers in 2007, mostly Japanese, who stayed for durations of a week or longer.

GAMMA-10 has orderly operations, using an experiment leader (similar to an Engineer in Charge of Operations or Chief Operator) and a key person. For GAMMA-10, the key person is a responsible person holding important keys to enable or activate machine systems. Their safety manual is bi-lingual. Personnel are given safety training annually by lectures and then they are also given assignments to read the safety manual.

All electrical work is performed with equipment de-energized so that there are no risks from live line work. Vacuum vessel entries, when necessary, are made with the fundamental principles of confined space entry in mind – sample the atmosphere before entry, use a buddy system, and a watch to monitor the workers who are inside the vessel.

GAMMA-10 operates an average of 100 shots/month. There is x-ray radiation and small amounts of neutron radiation. After pulsing the machine reads 5 mSv/month (0.5 rem per month) on the machine vacuum chamber exterior surface. Film badges are placed strategically around the machine, in ~30 locations, to monitor the emitted radiation on a monthly basis. The magnetic fringe field is only about 100 Gauss at 2 meters from the vacuum chamber surface. In most cases the exclusion area fence maintains greater than a 2 meter stand-off distance to the machine. That low field allows for tools and data collection computers to be stationed conveniently near the machine outside the fence. The staff needs to remain vigilant about any persons with cardiac pacemakers or other medical electronic devices who should remain in magnetic fields below 5 Gauss. In the experiment hall there is a camera and microphone monitored from the control room. Personnel use the magnetic token system in the control room to indicate they are working in the experiment hall.

GAMMA-10 has many diagnostics connected, but the machine remains orderly, clean, and it is kept in good condition. There are clear aisleways to walk around either side of the machine (although one end of the machine is very close to the building wall), and parts, tools, are maintained in good order. Gas cylinders are restrained well. The experiment hall is protected by a halon fire suppression system and the staff recently placed breathing oxygen cylinders with a 5-minute gas supply in the experiment hall in case a person is in the room when the halon 1301 discharges, even though the halon is breathable. The parts lay down area and storage near the machine are kept orderly as well. There were a few safety items from the previous visit that the staff dealt with showing a proactive safety attitude.

Issues called to the attention to the lab staff:

- Commend the staff on attention to safety and a proactive safety culture at this site .
- A formal confined space entry program exists along with a checklist for entry.
- Please post appropriate signs, international pictograms for exits and for hazards, including magnetic fields.
- Please review exit signs in the basement electrical equipment area for appropriate directions on evacuating the area .
- Please post appropriate signs to indicate the emergency equipment such as self contained breathing apparatus in the basement and for entry into the motor generator areas.
- Please consider installing cover plates over the open troughs for sliding doors. When doors are closed these areas are a trip hazard.
- Please evaluate fall protection railings at the elevated platforms at each end of the NB chambers.

March 12 – Tohoku University

Contacts:

Dr. Mamiko Sasao, Tohoku University
Dr. Sumio Kitajima, Tohoku University
Dr. Atsushi Okamoto, Tohoku University

US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)
Lee Cadwallader (INL)

DTALPHA

We visited two experiments in one building at Tohoku University Aobayama campus, the Sasao-Kitajima Laboratory. The first experiment was the Diagnostic Tools Assisted by Linear Plasma device for Helium Atom beam (DTALPHA) experiment. This experiment was built by Dr. Atsushi Okamoto in 2006 and had first plasma in 2007. Dr. Okamoto is a new professor at Tohoku University working under Dr. Mamiko Sasao and he now operates the DTALPHA. This machine is 2 meters long and has a magnetic field of 0.2 Tesla. The radiofrequency power is 3 kW at 13.56 MHz. The DTALPHA is close to, a few meters from, the heliac. The DTALPHA is configured similar to a mirror machine but without the end plug coils. It is a new experiment and looks orderly.

TU-Heliac

The second machine we visited was the Tohoku University Heliac (TU-Heliac). The TU-heliac is a helical axis stellarator, built in 1988; it was originally called the Asperator H-A. It is used to study high beta confinement (~0.5%) with a flexible magnetic configuration. The TU-Heliac is 0.48 m major radius and a 0.3 Tesla magnetic field. The RF frequency is 18.7 MHz and 35 kW. Dr. Sumio Kitajima showed us around the machine. There are a few students working in the building during the semester, perhaps 5 students. There are two staff and typically no foreign students. They did have a foreign student last year, from the Royal Technology Institute in Stockholm. He stayed for a year doing research with the department, but not on fusion machines. Most visitors to Tohoku University are short term, a few weeks. The TU-Heliac has had some attention to safety since the 2004 visit. The control room is cleaner and more orderly than in the past. Some international and some bi-lingual warning signs have been posted and a yellow plastic warning chain was installed around the machine. Fire extinguishers are not obstructed in their positions by the building doors. Since these units are the only fire protection for the building, it is important that they not be blocked from view or obstructed. There are warning signs on the doors, but there are no interlocks on the doors and no easy way to see anyone entering from the control room.

Dr. Kitajima conducts 1-day safety training for all new personnel (new students, transfer students, any new personnel) once each year in April. The personnel are told that if something does not look right, to ask and bring it to the attention of Dr. Kitajima or another professor. The campus safety manual and the individual experiment safety manuals are only in Japanese. Tohoku University has inspections of the lab 2 or 3 times per year, performed by the campus Department of Safety.

Issues called to the attention to the lab staff:

- Please move the posters and bulletin boards to allow the double doors to close across the building main aisleway so that the doors can be closed when operating either the DTALPHA or the TU-heliac experiments.
- Please place a pole-to-pole wire on unused capacitors to prevent any charge accumulation.
- Please continue efforts with disposal of unused equipment from the lab room.
- Please mark the emergency stop button in English.
- Please translate the experiment safety manuals to English.
- Please route power wires through proper openings in bottom of electrical panel (DTALPHA). Wires are currently fed into the panel with the panel door open which exposes the inside of the panel to personnel and could also damage the wires.
- Please provide more care when running multiple experiments in close proximity to each other, and the scheduling of maintenance work should be planned to not interfere with other experiments.

March 13 – Kyoto University (Yoshida Campus)

Contacts:

Dr. Takashi Maekawa, Kyoto University
Dr. Masaki Uchida, Kyoto University

US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)
Lee Cadwallader (INL)

LATE

We visited the Low Aspect ratio Torus Experiment (LATE) on the Yoshida campus of Kyoto University. Dr. Masaki Uchida guided us to the campus from our hotel. On our previous visit this was a machine that had caused concern among the JWG. This visit was much better. During the previous visit the main door to the building was held open by an exhaust hose from the LATE device, and the same hose prevented closure of the shielding door from the experiment room to the building hallway. This time the hose had been removed and Dr. Uchida had to key card into the main building door to allow us access. More safety signs have been posted to warn persons that a fusion experiment was operating in the building, although most of the signs were in Japanese.

The LATE experiment is 1 meter tall and the outside diameter is also 1 meter. The magnetic field is small at 0.048 Tesla (480 Gauss) for 10 second pulses and 0.1 Tesla (1,150 Gauss) for 0.3 second pulses when the short pulses are run. RF heating is 2.45 GHz at 10 kW continuous wave or 30 kW for 2 seconds of heating. The plasma current is 20 kA maximum. No one is allowed in the LATE room during operation since there can be some leakage of radiofrequency energy during shots. The experiment room is thick walled concrete and the main door is interlocked to the control room; the door is very thick and quite heavy to move. Exterior doors are locked.

A safety book (pamphlet) published by the university is given to students each April and a lecturer gives a 1-hour session on safety training in general. There is a 1-day training session each April that is mandatory for students who work in laboratories on campus. LATE has three professors, eight graduate students, 3 undergraduate students, and 3 technical staff to run the machine. The LATE machine does not currently have any foreign students on site or foreign researchers visiting the machine.

Overall, the JWG team believed that the staff of LATE are doing well with the small amount of funding that they have for the hazard levels of the LATE machine. Some progress with safety has been made at this site so please keep up the good work.

Issues called to the attention to the lab staff:

- Please post appropriate signs, international pictograms for exits and for hazards.
- Please address the machine service line trench and flexible vacuum line people must step over (without stepping into the trench) to access the machine.
- Please review and augment gas cylinder safety (cylinder caps and chains).
- Please review combustible materials in the experiment hall and remove any unneeded materials to storage (paint, oil, and other cans stacked along the walls).
- Please mark the microwave guide channel at head height with warning tape.
- Please post a new sign at the emergency stop button on the column in the experiment hall to replace the faded, existing sign.
- Please repaint or replace the sign on the door to the experiment hall, the sign is worn and unreadable.
- Please translate the experiment safety manual to English.

March 14 – Kyoto University Uji Campus

Contacts:

Dr. Hiroyuki Okada, Kyoto University Uji campus

US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)
Lee Cadwallader (INL)

Heliotron J

We visited the Heliotron J machine on the Uji campus of Kyoto University. The Yoshida campus is the main campus and Uji is the second campus for this university. Dr. Hiroyuki Okada picked us up at our hotel and led us on the tour. Dr. Okada told us that the Institute of Advanced Energy has a safety committee and this committee gives the students safety training each spring (May or June). The training is a 1-day session that covers the basics of heliotron operations – electrical safety, chemical safety, machine shop operations, high pressure safety, laser safety, heavy load lifting, x-ray safety, fire extinguishment, emergency procedures, and safety procedures with the Heliotron J. Any students or staff requiring other training, receive such training one-on-one as needed.

Dr. Okada showed us the list of suggested safety items from our 2004 visit and discussed how they had addressed each item. They take safety seriously and wanted to address all the items. The items that were low and modest expense, they took action. The expensive items they did not address since they did not have the funding to make any changes. The expensive items we noted in 2004 are not highly likely to pose hazards to visiting researchers.

The Heliotron J is a helical axis heliotron, major radius = 1.2 m, minor radius = 0.17 m, with a magnetic field of 1.5 Tesla. The machine uses 0.5 MW of ECH at 70 GHz, 0.8 MW of ICRF at 19 MHz, and 0.7 MW of neutral beam heating at 30 kV. The Heliotron allows manned entry into the machine hall between shots but also maintains vigilance for x-ray radiation exposure. There is a ten-minute dwell time between pulses.

The Heliotron J has several visiting researchers each year, 10-15 persons, including students. Most of these are Japanese, occasionally they have foreign visitors. They do not have any foreign students or visitors at present. Most visitors stay 1-2 weeks. Their safety training is not as rigorous as the students and staff who work on the machine all year.

Issues called to the attention to the lab staff:

- Good use of appropriate signs and international pictograms for exits and for hazards.
- Good provision for space around the machine, good housekeeping around the machine.
- Please mount the emergency stop button instead of allowing it to lie on the floor near the machine.
- Please replace the burnt out shot warning yellow strobe light bulb on the machine deck.
- Please put safety cages on the small lights that mark walkways in the electrical rooms
- Please review and remove unused fire extinguisher signs in the electrical rooms.
- Please post appropriate signs for fire exit paths from the diagnostic and heating control rooms next to the main control room.

- Please use two safety chains on gas cylinders in the hallway rack on the main floor; the gas cylinders can "kick out" from the bottom of the rack during an earthquake when they have only one chain mounted high on the cylinder.
- Please investigate the sodium carbonate formation on the electrical equipment
- Please consider protecting glass ion gauge with a metal shield to prevent damage and possible injury to personnel.
- Please consider making a one-page bi-lingual safety briefing for short-term visitors.

<u>March 17 – Kyushu University</u>

Contacts:

Dr. Hideki Zushi, Kyushu University
Dr. Shunjiro Shinohara, Kyushu University
Dr. Kohnosuke Sato, Kyushu University
Dr. Atsushi Mase, Kyushu University
Dr. Shigeru Inagaki, Kyushu University

US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)

<u>QUEST</u>

Dr. Hideki Zushi greeted us and opened our visit to the QUEST (Q-shu University Experiment w/ Steady State Spherical Tokamak) machine. The aim of the QUEST Project is to investigate both long duration current drive of a spherical tokamak plasma and plasma-wall interaction with advanced wall control. This machine is still under construction but largely complete.

Several other small fusion experiment laboratories were toured with Dr. Shinohara, such as the Helicon Plasma Source. Research associate, Shigeru Inagaki assisted with the explanations of the devices and status of research. This area is referred to as the Tanaka lab.

Dr. Atsushi Mase provided a tour of several newer laboratory spaces that were designed and fabricated according to modern research laboratories standards. The design was very interesting and very organized. It is very easy to locate the services and source of potential hazards. The circuit breaker panels are located in the overhead in close proximity to the experiments.

Two days of safety training are performed at the beginning of the semester for all of the students. Specific additional laboratory training is also performed and signed by the instructor and student to show joint ownership and understanding. In addition, the University safety organization provides oversight review of the facilities every 3 months. An annual independent safety review is performed by an outside contractor.

Issues called to the attention to the lab staff:

Tanaka Lab

- Please improve protective plates for wiring on floor.
- Please fasten shelves to walls to account for earthquake conditions.
- Please protect glass ion gauge with a cage.

- Please increase the space for personnel access and exit near the Helicon Plasma Source. A diagnostic rack could be moved back 30 cm to improve this condition.

Mase labs
- Excellent design and installation of gas supplies.
- Excellent design and installation of electrical power supplies.
- Please consider appropriate locations of fire extinguishers so they are easily recognized and accessible.
- Please consider removing heavy items on top of cabinets. Items could fall and cause injury during an earthquake.
- Please remove the caution sign “Danger-Laser Radiation” when the hazard does not exist.
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March 18 – Osaka University

Contacts:

Dr. Takayoshi Norimatsu, Osaka University
Dr. Hiroshi Horiike, Osaka University
Dr. Hiroo Kondo, Osaka University
Dr. Hiroshi Azechi, Osaka University

US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)

Institute of Laser Engineering

Dr. Takayoshi Norimatsu and Dr. Hiroshi Azechi greeted us and opened our visit to the Institute of Laser Engineering. The facility is quite large and complex using many high powered lasers to study high energy density science of physics for fusion plasmas, astrophysics, and other fields related to ultra high density, high temperature, and high pressure states. The latest addition to this world class facility is the GEKKO XII Peta-Watt laser. The facility also contains a tritium target loading facility.

In general, this facility is a fine example of precision engineering and construction. The facilities are well organized with proper space for facility support and access for operations and maintenance. Housekeeping and proper storage of materials was clearly evident with attention to detail.

Issues called to the attention to the lab staff:
- Please review locations of fire extinguishers so they are easily recognized and accessible. Several were misplaced.
- Please consider fastening gas cylinders in the pellet facility. Several gas cylinders were not fastened and were not in use.
- Please consider protecting cables properly. Several cables in the diagnostic room were routed through doorways unprotected. If the door were to close, the cables would be damaged and could cause an electrical shock.
- There was not clear evidence of a formal confined space entry program. We suggest that other universities share their programs among each other.
- Please cover hole in floor behind main control panel.

March 19 – National Institute for Fusion Science

Contacts:

Dr. Akio Komori, NIFS
Dr. Nobuaki Noda, NIFS
Dr. Osamu Kaneko, NIFS
Dr. Masashi Iima, NIFS
Dr. Hiroshi Yamada, NIFS
Dr. Kazuya Takahata, NIFS
Dr. Kiyohiko Nishimura, NIFS
Mr. Hiromi Hayashi, NIFS

US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)

We appreciate the opportunity to meet with the Director of LHD project, Dr. Komori. Dr. Kaneko and Dr. Noda greeted us and provided the extensive tours of the many facilities at NIFS along with Dr. Nishimura. The Large Helical Device is the latest research experiment at this facility which utilizes hydrogen gas and heating power up to 25 MW to research the continued possibilities associated with fusion energy. In addition to the LHD, NIFS also provides research and development facilities for superconducting magnet systems, fusion reactor materials, fusion engineering research and university-based studies in physics.

Issues called to the attention to the lab staff:

Superconducting Laboratory

- Facility was very clean and organized.
- Protection of wiring and hoses on floors was very good.
- Please consider installing additional toe-boards at base of railings for all elevated areas. Some areas did have proper installations.
- Please consider using a face shield when transferring liquid nitrogen from one dewar to another.
- Please consider using a checklist or installing interlocks to ensure personnel safety prior to conducting operations. Such methods do not currently exist.
- Remove heavy items on top of cabinets. Items could fall and cause injury during an earthquake.
- Please consider installing machine guards on rotating shafts for pumps in basement.
- Please post sign at entry to area when ear protection is required.

Fusion Engineering Laboratory

- Please consider improving personnel access around the neutral beam areas.
- Please consider improving material storage to improve access to electrical panels. Access to several panels was blocked.
- A panel cover was removed from an electrical panel on a wall and covered with plastic sheeting. The panel cover was then leaning against plastic sheeting and could then come in contact with internal areas of panel. Please consider a better method or replace panel cover.

Research and Development Laboratory

- Protection of equipment and personnel in the event of seismic events was very good. Cabinets and shelving were fastened to walls.
- Several areas need to be reviewed for proper protection of wiring on floor surfaces.
- Please consider improving material storage to improve access to electrical panels. Access to several panels was blocked.

<u>March 21 – Japan Atomic Energy Agency (JAEA)</u>

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US Participants:

Rick Savercool (GA)
Keith Rule (PPPL)

<u>Naka Fusion Institute</u>

Dr. Sato and Dr. Hosogane greeted us and opened our visit with a meeting with Dr. T. Sato, the Director of Administrative Services. This meeting was followed by a presentation of the safety administration and activities at JAEA by Dr. Ashikagaya. Tours of the following facilities were conducted at Naka: JT-60 torus hall, power generation, superconducting magnet research, RF heating research, and the JAEA Electron Beam Irradiation Stand (JEBIS). Tours of the Fusion Neutronics Source and Tritium Process Laboratory were conducted in Tokai.

Issues called to the attention to the lab staff:

Power Generation Areas

- The head of this facility has developed a very comprehensive electrical safety program which requires zero energy checks and several types of energy checkers including a wrist band type. This program also includes testing of helmets in addition to other electrical protective equipment.
- Please consider installing a guard to prevent access to the rotating shaft on a 30 horsepower pump located in the basement of the MG area.
- Please consider replacing plastic yellow chain with a metal chain. Plastic chain is currently providing fall protection to pit.

JT-60 Torus Hall

- Excellent facility design. Comprehensive safety and radiation safety program is in place.
- Housekeeping and cleanliness of this facility is outstanding.
- Please consider using a five point harness for fall protection instead of a belt. U.S. visiting team will provide history behind requirements for use in U.S.A. and information regarding actual harnesses.
- Please replace unsafe power cord on vacuum pump.

Superconducting Magnet Facility

- Controlled areas for magnetic fields are well defined and posted.
- Facility specific training is conducted for visiting workers for 1-2 hours.
- Please consider installing a metal chain at the top of the ladder for access to the device. Chain will provide fall protection.

RF Heating Facility

- In general, a considerable amount of this facility is used for storage.
- Please consider better defining and physically separating the research area from the storage area.
- Please consider improving the path and protection of wiring.

JEBIS

- Double door that is an emergency exit to outside has very limited access. Door is normally locked but is designated as an exit door. Please consider clearing path to door.

Fusion Neutronics Source

- Facility is well organized. Radiation protection program is evident and properly implemented.
- Please consider removing items that are blocking access to several electrical panels at the facility.

Tritium Process Laboratory

- Please consider review of materials stored in front of electrical panels

D. ACKNOWLEDGEMENTS

The U.S.-Japan Safety Monitor JWG members would like to thank all the individuals who participated in the facility tours. The U.S. JWG members especially thank the hosting institutions for their very gracious hospitality. In addition, the U.S. members were very appreciative of Yuichi Takase (the Japanese team leader) and others for their efforts in organizing the trip and providing guides as needed. Their attention to detail, prior to and during the trip, made the entire event both profitable and enjoyable to all.

E. AGENDA

Saturday, March 8, 2008 - All three JWG members depart the U.S.

Sunday, March 9, 2008 - All members arrive in Japan.

Monday, March 10, 2008 - Visit Kashiwa campus of the University of Tokyo.

Tuesday, March 11, 2008 - Visit University of Tsukuba. Travel to Sendai.

Wednesday, March 12, 2008 - Visit Tohoku University. Travel on to Kyoto.

Thursday, March 13, 2008 - Visit Yoshida campus of Kyoto University.

Friday, March 14, 2008 - Visit Uji campus of Kyoto University.

Saturday, March 15, 2008 - Lee Cadwallader returns to the US.

Sunday, March 16, 2008 - Travel to Fukuoka

Monday, March 17, 2008 - Visit Kyushu University. Travel to Osaka.

Tuesday, March 18, 2008 – Visit Osaka University. Travel to Nagoya.

Wednesday, March 19, 2008 – Visit the National Institute for Fusion Science (NIFS).

Thursday, March 20, 2008 – Travel to Mito.

Friday, March 21, 2008 – Visit the Japan Atomic Energy Agency (JAEA).

Saturday, March 22, 2008 - Travel from Mito to Narita airport. Rick Savercool and Keith Rule depart for U.S. and arrive in U.S. the same day.