(942 Pages)

Group EY

(Records Withheld In Part)

The following contains the RST and Global Assessments.

*Global Assessments are incldued because a report refers to the RST Assessment as a Global Assessment as well.

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400~~0430~~ EDT March 25, 2011

UNIT ONE

STATUS:

Core Status: Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL).
Vessel temperatures 149~~230~~C at bottom drain, 197~~249~~C at FW nozzle (b)(6) ~~0430 JDT 3/24)~~ (NISA 1800 JDT 3/25)
RPV at 65.7 psi (increasing trend), DW and torus pressure at 40 psi (decreasing trend)~~increasing as a result of increased flow~~ (b)(6) ~~0430 JDT3/24)~~ (NISA 1800 JDT 3/25).

Core Cooling: Fresh water injection initiated at 1537 hrs JDT 3/25~~Saltwater injection~~, injecting through feedwater 120~~119 l/min (JAIF), or 300~~l/min or 31.7 g/m (NISA)~~, or 7gal/min (TEPCO)~~; Recirculation pump seals have likely failed. (GEH) ; Expect to go to freshwater late on 3/25

Primary Containment: Not damaged, 40~~53~~ psia (TEPCO was considering venting on 3/24)

Secondary Containment: Severely damaged (hydrogen explosion)

Spent Fuel Pool: Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)

Rad levels: DW 3900?~~4780~~ R/hr, Torus 2490?~~3490~~ R/hr (source instruments unknown), Outside plant: 100R/hr debris outside Rx building (covered); 26mR/hr at gate (variable)~~less than 6R/hr~~ (INPO 0900 hrs 3/25/11~~TEPCO 9pm 3/20/11~~)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1 & U-3.

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water~~seawater~~ through the feedwater system is cooling the vessel but limited if any flow past the fuel. GE believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. (b)(4),(b)(5) (b)(4), There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400~~0430~~ EDT March 25, 2011

RECOMMENDATIONS:

(b)(4),(b)(5)

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- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
  - Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation (b)(6)

- Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen (b)(6)

- (b)(4),(b)(5)
  (b)(4),(b)(5) Containment spray should be secured before 2 psia. to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
  - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
14000430 EDT March 25, 2011

UNIT TWO

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO).
	(b)(4),(b)(5)
Core Cooling:	Seawater injection through RHR via fire water, bottom head temperature 1045C, feed water nozzle temperature 1070C (NISA 1800 JDT 3/25/11) (JAIF, NISA,,TEPCO) Recirculation pump seals have likely failed. (b)(6) . Expect to go to freshwater late on 3/25
Primary Containment:	Damage suspected (JAIF, NISA, TEPCO)
Secondary Containment:	Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)
Spent Fuel Pool:	Fuel covered, seawater injected on March 20, fuel pool temperature 5240C (JAIF, NISA, TEPCO 1800 JDT 3/25/11)
Rad Levels:	Drywell 45604590 R/hr; Torus 154193 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:

- (b)(4),(b)(5)

(b)(4),(b)(5)

- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
    - Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a

hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)

- (b)(4),(b)(5)
  (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
- Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)

- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400~~0430~~ EDT March 25, 2011

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	Freshwater injection via fire line initiated 1802 JDT 3/25/11 (NISA)Seawater injection through RHR, bottom head temperature 111~~185~~C, feed water nozzle temperature Unreliable~~81C~~ (JAIF, NISA 1800 JDT 3/25/11, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go freshwater cooling late on 3/25
Primary Containment	Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), spraying and pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 5100~~6000~~ R/hr, torus 150~~458~~ R/hr (b)(6) 0900 3/25/11 Call source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4) (b)(6)

Unit 3 turbine building basement is flooding. Samples of water indicate some RCS fluid is present (b)(4),(b)(5) Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS:

(b)(4),(b)(5)

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(b)(4),(b)(5)

- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
    - Steam/condensing could jeopardize inert environment , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5)
    (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
    - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of *Fukushima Daiichi* Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400~~0430~~ EDT March 25, 2011

UNIT FOUR

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature is unknown~~back up to 100 C~~ (NISA); (b)(4),(b)(5) (b)(4),(b)(5)
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
14000430 EDT March 25, 2011

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling not functioning Temperature 37.9 C (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400~~0430~~ EDT March 25, 2011

UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400~~0430~~ EDT March 25, 2011

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400 EDT March 25, 2011

UNIT ONE

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL). Vessel temperatures 149C at bottom drain, 197C at FW nozzle (NISA 1800 JDT 3/25) RPV at 65.7 psig (increasing trend), DW and torus pressure at 40 psig (decreasing trend) (NISA 1800 JDT 3/25).
Core Cooling:	Fresh water injection initiated at 1537 hrs JDT 3/25, injecting through feedwater 120l/min or 31.7 g/m (NISA); Recirculation pump seals have likely failed. (GEH) ; Expect to go to freshwater late on 3/25
Primary Containment:	Not damaged, 40 psia (TEPCO was considering venting on 3/24)
Secondary Containment:	Severely damaged (hydrogen explosion)
Spent Fuel Pool:	Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)
Rad levels:	DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant: 26mR/hr at gate (variable) (INPO 0900 hrs 3/25/11)
Other:	Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1 & U-3.

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GE believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. [redacted] (b)(4),(b)(5) There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECOMMENDATIONS:

- Make the protection of primary containment a priority

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(b)(4),(b)(5)

- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
  - Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)

(b)(4),(b)(5)

- (b)(4),(b)(5) Containment spray should be secured before 2 psia. to prevent opening vacuum breakers.

- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
    - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400 EDT March 25, 2011

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UNIT TWO

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO). (b)(4),(b)(5)
Core Cooling:	Seawater injection through RHR via fire water, bottom head temperature 104C, feed water nozzle temperature 107C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed (b)(6) Expect to go to freshwater late on 3/25
Primary Containment:	Damage suspected (JAIF, NISA, TEPCO)
Secondary Containment:	Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)
Spent Fuel Pool:	Fuel covered, seawater injected on March 20, fuel pool temperature 52C (JAIF, NISA, TEPCO 1800 JDT 3/25/11)
Rad Levels:	Drywell 4560 R/hr; Torus 154 R/hr (source instruments unknown); Outside plant: 26mR/hr at gate (variable) (b)(6) 0900 hrs 3/25/11)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400 EDT March 25, 2011

RECOMMENDATIONS:

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(b)(4),(b)(5)

- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
    - Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)

- o (b)(4),(b)(5)
  (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
- o (b)(4),(b)(5)
- o When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- o

- (b)(4),(b)(5)
  - o Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400 EDT March 25, 2011

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	Freshwater injection via fire line initiated 1802 JDT 3/25/11 (NISA)Seawater injection through RHR, bottom head temperature 111C, feed water nozzle temperature Unreliable (JAIF, NISA 1800 JDT 3/25/11, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go freshwater cooling late on 3/25
Primary Containment	Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), spraying and pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 5100 R/hr, torus 150 R/hr (b)(6) 0900 3/25/11 Call source instruments unknown); Outside plant: 26mR/hr at gate (variable) (b)(6) 0900 hrs 3/25/11); 100 R/hr debris outside Rx building (covered).
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4) (b)(6) Unit 3 turbine building basement is flooding. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). (b)(4),(b)(5) (b)(4),(b)(5) Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS:

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(b)(4),(b)(5)

(b)(4),(b)(5)

- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
    - Steam/condensing could jeopardize inert environment , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen (b)(6)
- (b)(4),(b)(5)

  (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
    - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400 EDT March 25, 2011

UNIT FOUR

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature is unknown (NISA); (b)(4),(b)(5) 3/24
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning Temperature 37.9 C (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400 EDT March 25, 2011

UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
1400 EDT March 25, 2011

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

From: Evans, Michele
Sent: Friday, March 25, 2011 3:16 PM
To: McDermott, Brian; Holahan, Patricia; Correia, Richard
Subject: FW: ~~SENSITIVE OUO~~ - RST Assessment
Attachments: 03-25-11 0430 RST Assessment Document.docx

From: Brown, Frederick
Sent: Friday, March 25, 2011 9:08 AM
To: Bahadur, Sher; Blount, Tom; Cheok, Michael; Evans, Michele; Ferrell, Kimberly; Galloway, Melanie; Giitter, Joseph; Givvines, Mary; Hiland, Patrick; Holian, Brian; Howe, Allen; Lee, Samson; Lubinski, John; McGinty, Tim; Nelson, Robert; Quay, Theodore; Ruland, William; Skeen, David
Subject: FYI: ~~SENSITIVE OUO~~ - RST Assessment

FYI – a really good snap shot. Kudos to Bill Ruland, Brian Holian, and Dave Skeen for their work and leadership in putting this together.

Note the OUO nature

From: RST01 Hoc
Sent: Friday, March 25, 2011 8:05 AM
To: Brown, Frederick
Subject: RST Assessment

~~Official Use Only~~

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

UNIT ONE

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL). Vessel temperatures 230C at bottom drain, 240C at FW nozzle (b)(6) 0430 JDT 3/24) RPV, DW and torus pressure increasing as a result of increased flow (b)(6) 0430 JDT3/24).
Core Cooling:	Saltwater injection, injecting through feedwater 119 l/min (JAIF), or 300l/min (NISA), or 7gal/min (TEPCO); Recirculation pump seals have likely failed. (GEH); Expect to go to freshwater late on 3/25
Primary Containment:	Not damaged, 58 psia (TEPCO was considering venting on 3/24
Secondary Containment:	Severely damaged (hydrogen explosion)
Spent Fuel Pool:	Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)
Rad levels:	DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant less than 6R/hr (TEPCO 9pm 3/20/11)
Other:	Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1 & U-3.

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting seawater through the feedwater system is cooling the vessel but limited if any flow past the fuel. GE believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. (b)(4),(b)(5) There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECOMMENDATIONS:

- (b)(4),(b)(5)

- (b)(4),(b)(5)
- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
    - Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen (b)(6)
- Maintain venting capability
    - Vent as necessary
- (b)(4),(b)(5) Containment spray should be secured before 2 psia. to prevent opening vacuum breakers.
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
    - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

UNIT TWO

STATUS:

Core Status: Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO).

(b)(4),(b)(5)

Core Cooling: Seawater injection through RHR, bottom head temperature 105C, feed water nozzle temperature 100C (NISA) (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go to freshwater late on 3/25

Primary Containment: Damage suspected (JAIF, NISA, TEPCO)

Secondary Containment: Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)

Spent Fuel Pool: Fuel covered, seawater injected on March 20, fuel pool temperature 40C (JAIF, NISA, TEPCO)

Rad Levels: Drywell 4590 R/hr; Torus 193 R/hr (source instruments unknown)

Other: External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited flow past the fuel. (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:

- (b)(4),(b)(5)

- (b)(4),(b)(5)
- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
  - Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
- Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)

- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)

- (b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	Seawater injection through RHR, bottom head temperature 185C, feed water nozzle temperature 81C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go freshwater cooling late on 3/25
Primary Containment	Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 6000 R/hr, torus 158 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4) (b)(6)

RECOMMENDATIONS:

- (b)(4),(b)(5)
    - Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
        - Steam/condensing could jeopardize inert environment , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
        - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
    - (b)(4),(b)(5)
    - (b)(4),(b)(5)
      (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
    - (b)(4),(b)(5)
    - When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
    - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)

- (b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

<u>UNIT FOUR</u>

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature back up to 100 C (NISA); (b)(4),(b)(5) (b)(4),(b)(5)
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling not functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

**RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011**

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0430 EDT March 245, 2011

UNIT ONE

STATUS:

Core Status: Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO)

The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL).

Vessel temperatures 230C at bottom drain, 240C at FW nozzle [redacted] (b)(6) 0430 JDT 3/24)

RPV, DW and torus pressure increasing as a result of increased flow [redacted] (b)(6) 0430 JDT3/24).

Core Cooling: Saltwater~~Freshwater~~ injection, injecting through feedwater 119 l/min (JAIF), or 300l/min (NISA), or 7gal/min (TEPCO); Recirculation pump seals have likely failed. (GEH) ; Expect to go to freshwater late on 3/25

Primary Containment: Not damaged, 58 psia (TEPCO iwas considering venting on 3/24)

Secondary Containment: Severely damaged (hydrogen explosion)

Spent Fuel Pool: Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)

Rad levels: DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant less than 6R/hr (TEPCO 9pm 3/20/11)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1 & U-3.

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting sea[redacted] (b)(4),(b)(5) There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0430 EDT March 245, 2011

RECOMMENDATIONS:

- (b)(4),(b)(5)
    - Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
        - Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
        - Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen (b)(6)
    - (b)(4),(b)(5) Containment spray should be secured before 2 lbs psia. to prevent opening vacuum breakers.
    - (b)(4),(b)(5)
    - When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
    - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)

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- (b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 0430 EDT March 245, 2011

UNIT TWO

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO).
	(b)(4),(b)(5)
Core Cooling:	Seawater injection through RHR, bottom head temperature 105C, feed water nozzle temperature 100C (NISA) (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go to freshwater late on 3/25
Primary Containment:	Damage suspected (JAIF, NISA, TEPCO)
Secondary Containment:	Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)
Spent Fuel Pool:	Fuel covered, seawater injected on March 20, fuel pool temperature 40C (JAIF, NISA, TEPCO)
Rad Levels:	Drywell 4590 R/hr; Torus 193 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Injecting seawater through the RHR system is cooling the vessel, but with limited; flow past the fuel. (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:

- (b)(4),(b)(5)

- (b)(4),(b)(5)
- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
  - Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
- Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)

Ensure SFP level maintained as full as possible

(b)(4),(b)(5)

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- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0430 EDT March 245, 2011

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	Seawater injection through RHR, bottom head temperature 185C, feed water nozzle temperature 81C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go freshwater cooling late on 3/25
Primary Containment	Damage suspected ~~suspected~~ (JAIF, NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 6000 R/hr, torus 158 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4) (b)(6)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0430 EDT March 2~~4~~5, 2011

RECOMMENDATIONS:

- (b)(4),(b)(5)
    - Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
        - Steam/condensing could jeopardize inert environment , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
        - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6).
    - (b)(4),(b)(5)
        - (b)(4),(b)(5) Containment spray should be secured before 2 psig to prevent opening vacuum breakers.
    - (b)(4),(b)(5)
    - When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6).
- (b)(4),(b)(5)
    - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
    - (b)(4),(b)(5)

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(b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0430 EDT March 245, 2011

UNIT FOUR

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature back up to 100 C (NISA); (b)(4),(b)(5) (b)(4),(b)(5)
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0430 EDT March 24~~5~~, 2011

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling not functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0430 EDT March 245, 2011

UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0430 EDT March 24~~4~~5, 2011

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

From: RST01B Hoc
Sent: Friday, March 25, 2011 3:04 PM
To: trevor.cook@nuclear.energy.gov; sal.golub@nuclear.energy.gov
Subject: FW: NRC Reactor Safety Team Assessment 1400 EDT 3/25/11
Attachments: 03-25-11 1400 RST Assessment DocumentRedline.docx; 03-25-11 1400 RST Assessment Document.docx

Update of the 13 page NRC Reactor Safety team assessment.
Rich

From: RST01 Hoc
Sent: Friday, March 25, 2011 3:02 PM
To: RST01B Hoc
Subject: NRC Reactor Safety Team Assessment 1400 EDT 3/25/11

All,

Please find the 1400 EDT NRC RST Assessment attached. I have included a red-line version to show changes, and a clean version.

Regards,
Eric Thomas
NRC RST

From: Huckaby, Thomas S.(INPO) [mailto (b)(6)
Sent: Friday, March 25, 2011 9:48 AM
To: Huckaby, Thomas S.(INPO); Garchow, David F.(INPO); (b)(6) (b)(6) RST01 Hoc
Subject: 3-25 1100 Industry technical conference call

Please review the attachments for discussion on the 1100 conference call.

Thanks,
Thom Huckaby
INPO
ER Sr. Evaluator

From: Huckaby, Thomas S.(INPO)
Sent: Thursday, March 24, 2011 3:15 PM
To: (b)(6)
Subject: RE: Review the RST Assessment Recommendations

Enclosed is the revised document from our 1300 conference call. Please provide any comments or corrections to me and I will forward back to the NRC

<< File: 03-24-11 1500 RST Assessment Document.docx >>
Thanks,
Thom Huckaby
INPO ER Sr evaluator

-----Original Appointment-----
From: Czekalla, Melissa B. (INPO)
Sent: Thursday, March 24, 2011 12:25 PM
To: (b)(6)
Subject: Review the RST Assessment Recommendations
When: Thursday, March 24, 2011 1:00 PM-3:00 PM (GMT-05:00) Eastern Time (US & Canada).
Where:

When: Thursday, March 24, 2011 1:00 PM-3:00 PM (GMT-05:00) Eastern Time (US & Canada).

Note: The GMT offset above does not reflect daylight saving time adjustments.

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<< File: RST 3-24-11 0600 assessment document.docx >>

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(b)(5)

Tomorrow's meeting was set for 2000.

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

From: RST01 Hoc
Sent: Friday, March 25, 2011 2:06 PM
To: RST01A Hoc
Subject: FW: 03-25-11 0430 RST Assessment Document.docx
Attachments: 03-25-11 0430 RST Assessment Document.docx

From: Huckaby, Thomas S.(INPO) [mailto (b)(6)] **On Behalf Of** INPOERCTech
Sent: Friday, March 25, 2011 1:44 PM
To: RST01 Hoc
Subject: FW: 03-25-11 0430 RST Assessment Document.docx

From: Reandeau, Michael A. (INPO)
Sent: Friday, March 25, 2011 1:19 PM
To: INPOERCTech
Subject: 03-25-11 0430 RST Assessment Document.docx

Tom, my comments are noted on the attachment.

Mike Reandeau

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

<u>Comments provided for Unit 1 apply to Units 2 and 3 also.</u>

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<u>UNIT ONE</u>

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL). Vessel temperatures 230C at bottom drain, 240C at FW nozzle [redacted] (b)(6) 0430 JDT 3/24) RPV, DW and torus pressure increasing as a result of increased flow (GEH/INPO 0430 JDT3/24).
Core Cooling:	Saltwater injection, injecting through feedwater 119 l/min (JAIF), or 300l/min (NISA), or 7gal/min (TEPCO); Recirculation pump seals have likely failed. (GEH) ; Expect to go to freshwater late on 3/25
Primary Containment:	Not damaged, 58 psia (TEPCO was considering venting on 3/24
Secondary Containment:	Severely damaged (hydrogen explosion)
Spent Fuel Pool:	Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)
Rad levels:	DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant less than 6R/hr (TEPCO 9pm 3/20/11)
Other:	Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1 & U-3.

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting se[redacted] (b)(4),(b)(5) [redacted] (b)(4),(b)(5) There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (~~on~~ 3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

RECOMMENDATIONS:

(b)(4),(b)(5)

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- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
    - Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5)

- (b)(4),(b)(5)
  (b)(4),(b)(5) Containment spray should be secured before 2 psia. to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

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- (b)(4),(b)(5)
  - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

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UNIT TWO

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO).
	(b)(4),(b)(5)
Core Cooling:	Seawater injection through RHR, bottom head temperature 105C, feed water nozzle temperature 100C (NISA) (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go to freshwater late on 3/25
Primary Containment:	Damage suspected (JAIF, NISA, TEPCO)
Secondary Containment:	Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)
Spent Fuel Pool:	Fuel covered, seawater injected on March 20, fuel pool temperature 40C (JAIF, NISA, TEPCO)
Rad Levels:	Drywell 4590 R/hr; Torus 193 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:

- (b)(4),(b)(5)

- (b)(4),(b)(5)
- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert (b)(6)
  - Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5)

  (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
- Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)

- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)

- (b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	Seawater injection through RHR, bottom head temperature 185C, feed water nozzle temperature 81C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go freshwater cooling late on 3/25
Primary Containment	Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 6000 R/hr, torus 158 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited flow past the fuel. (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). (b)(6)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

RECOMMENDATIONS:

- (b)(4),(b)(5)
    - Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
        - Steam/condensing could jeopardize inert environment , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
        - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
    - (b)(4),(b)(5)
        (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
    - (b)(4),(b)(5)
    - When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
    - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)

- (b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
***Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors* (with Bettis and KAPL), and DOE/NE**
0430 EDT March 25, 2011

UNIT FOUR

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature back up to 100 C (NISA); (b)(4),(b)(5) (b)(4),(b)(5)
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

RST Assessment of Fukushima Daiichi Units,
***Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors* (with Bettis and KAPL), and DOE/NE**
0430 EDT March 25, 2011

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling not functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0430 EDT March 25, 2011

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

From: ET05 Hoc
Sent: Thursday, March 24, 2011 11:49 AM
To: Sheron, Brian; Lee, Richard
Cc: OST02 HOC; FOIA Response.hoc Resource
Attachments: RST 3-24-11 0600 assessment document.docx

Please find attached the current version of the RST assessment. It is currently being updated. This is to support Brian Sheron's participation in 1500 Congressional Call and RES staff's participation in DOE call at 1700.

RST Assessment of Fukushima Daiichi Units, 0600 March 24, 2011

UNIT ONE

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) the volume of sea water injected to cool the core has left enough salt to fill the lower head to the core plate (GEH, INPO, Bettis, KAPL) Vessel temperatures 230C at bottom drain, 240C at FW nozzle (b)(6) 0430 3/24) RPV, DW and torus pressure increasing as a result of increased flow (b)(6) 0430 3/24).
Core Cooling:	Seawater injection, injecting through feedwater 119 l/min, or 300l/min, or 7gal/min (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (GEH)
Primary Containment:	Not damaged, 58 psi (TEPCO is considering venting on 3/24)
Secondary Containment:	Severely damaged (hydrogen explosion)
Spent Fuel Pool:	Fuel covered, no seawater injected (b)(4),(b)(5) (JAIF, NISA, TEPCO).
Rad levels:	DW 4780 R/hr, Torus 3490 R/hr, Outside plant less than 6R/hr (TEPCO) 9pm 3/20/11)
Other:	Electric power available, equipment testing in progress (JAIF, NISA, TEPCO)

ASSESMENT:

Damaged fuel that may have fallen to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting seawater through the feedwater system is cooling the vessel but limited if any flow past the fuel. (b)(4),(b)(5)

(b)(4),(b)(5) There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation.

The primary containment is not damaged.

RECOMMENDATIONS:

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-

(b)(4),(b)(5)

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-
-

RST Assessment of Fukushima Daiichi Units, 0600 March 24, 2011

UNIT TWO

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling:	Seawater injection through RHR, bottom head temperature 105C, feed water nozzle temperature 105C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6)
Primary Containment:	Damage suspected (JAIF, NISA, TEPCO)
Secondary Containment:	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel covered, seawater injected on March 20, fuel pool temperature 51C (JAIF, NISA, TEPCO)
Rad Levels:	Drywell 4590 R/hr; Torus 193 R/hr
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESMENT:

Damaged fuel may have fallen to the bottom of the core and fuel in the lower region of the core is likely encased in salt (b)(4),(b)(5)

(b)(4),(b)(5)

Injecting seawater through the recirculation system is cooling the vessel, but with limited, if any, flow past the fuel (b)(4),(b)(5)

(b)(4),(b)(5) Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units, 0600 March 24, 2011

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	Seawater injection through RHR, bottom head temperature 185C, feed water nozzle temperature 81C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6)
Primary Containment	Damage suspected (JAIF, NISA, TEPCO)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level, spraying with sea water (JAIF, NISA, TEPCO)
Rad Levels:	
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESMENT:

Damaged fuel may have fallen to the bottom of the core and fuel in the lower region of the core is likely encased in salt (b)(4),(b)(5) (b)(4),(b)(5) Injecting seawater through the recirculation system is cooling the vessel, but with limited, if any, flow past the fuel. (b)(4),(b)(5) (b)(4),(b)(5) Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool.

RECOMMENDATIONS:

-
-
(b)(4),(b)(5)
-
-
-

RST Assessment of Fukushima Daiichi Units, 0600 March 24, 2011

UNIT FOUR

STATUS:	
Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature back up to 100 C (NISA); (b)(4),(b)(5) (b)(4),(b)(5)
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool.

RECOMMENDATIONS:

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units, 0600 March 24, 2011

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

UNIT ONE

STATUS:

Core Status: Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO)

The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL).

Vessel temperatures 230C at bottom drain, 240C at FW nozzle (b)(6) 0430 JDT 3/24)

RPV, DW and torus pressure increasing as a result of increased flow (b)(6) 0430 JDT3/24).

Core Cooling: Freshwater injection, injecting through feedwater 119 l/min (JAIF), or 300l/min (NISA), or 7gal/min (TEPCO) Recirculation pump seals have likely failed. (GEH)

Primary Containment: Not damaged, 58 psia (TEPCO is considering venting on 3/24)

Secondary Containment: Severely damaged (hydrogen explosion)

Spent Fuel Pool: Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)

Rad levels: DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant less than 6R/hr (TEPCO 9pm 3/20/11)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1 & U-3.

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting seawater through the feedwater system is cooling the vessel but limited if any flow past the fuel. (b)(4),(b)(5) (b)(4),(b)(5) There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

RECOMMENDATIONS:

- (b)(4),(b)(5)
  - Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
    - Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
  - (b)(4),(b)(5)
  - (b)(4),(b)(5) Containment spray should be secured before 2 lbs. to prevent opening vacuum breakers.
  - (b)(4),(b)(5)
  - When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
  - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

UNIT TWO

STATUS:

Core Status: Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO).

(b)(4),(b)(5)

Core Cooling: Seawater injection through RHR, bottom head temperature 105C, feed water nozzle temperature 100C (NISA) (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6)

Primary Containment: Damage suspected (JAIF, NISA, TEPCO)

Secondary Containment: Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)

Spent Fuel Pool: Fuel covered, seawater injected on March 20, fuel pool temperature 40C (JAIF, NISA, TEPCO)

Rad Levels: Drywell 4590 R/hr; Torus 193 R/hr (source instruments unknown)

Other: External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:

- (b)(4),(b)(5)

(b)(4),(b)(5)

- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
  - Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5)
- (b)(4),(b)(5) Containment spray should be secured before 2 lbs. to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
-

- (b)(4),(b)(5)
  - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	Seawater injection through RHR, bottom head temperature 185C, feed water nozzle temperature 81C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6)
Primary Containment	Damage suspected (JAIF, NISA, TEPCO)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 6000 R/hr, torus 158 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCo of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4) (b)(6)

RECOMMENDATIONS:

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

- (b)(4),(b)(5)
  - Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert – (b)(6)
    - Steam/condensing could jeopardize inert environment , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
  - (b)(4),(b)(5)
  - (b)(4),(b)(5) Containment spray should be secured before 2 lbs. to prevent opening vacuum breakers.
  - (b)(4),(b)(5)
  - When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
  - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

UNIT FOUR

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature back up to 100 C (NISA); (b)(4),(b)(5) 3/24
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool (based on information from TEPCo of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling not functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
2000 EDT March 24, 2011

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

From: OST01 HOC
Sent: Thursday, March 24, 2011 4:01 AM
To: Virgilio, Martin; McGinty, Tim; Boger, Bruce; ET07 Hoc
Subject: FW: RST draft assessment for review
Attachments: RST 3-23-11 2000 assessment document.docx

From: HOO Hoc
Sent: Thursday, March 24, 2011 3:58 AM
To: LIA07 Hoc; OST01 HOC; OST02 HOC; OST03 HOC
Subject: FW: RST draft assessment for review

From: RST01 Hoc
Sent: Thursday, March 24, 2011 3:55 AM
To: GE Hitachi Nuclear Response Team (GE Power & Water); Watford, Glen A. (GE Power & Water); inpoerc@inpo.org
Cc: HOO Hoc
Subject: FW: RST draft assessment for review

Please call NRC Headquarters Operations Center (301-816-5100) to be placed on Site Team Conference

From: RST01 Hoc
Sent: Thursday, March 24, 2011 3:33 AM
To: Nakanishi, Tony
Subject: RST draft assessment for review

Please see attached assessment for 0430 (EST) phone call

~~OUO~~

RST Assessment of Fukushima Daiichi Units, 2100 March 23, 2011

UNIT ONE

STATUS

Core Status: damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) the volume of sea water injected to cool the core has left enough salt to fill the lower head to the core plate (GEH, INPO, Bettis, KAPL) Vessel temperatures 350C at bottom drain, 345C at FW nozzle (TEPCO)
Core Cooling: seawater injection, injecting through Core Spray and Feed Water 119 l/min, or 300l/min, or 7gal/min (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (GEH)
Primary Containment: not damaged
Secondary Containment: Severely damaged (hydrogen explosion)
Spent Fuel Pool: fuel covered, no seawater injected (JAIF, NISA, TEPCO)
Rad levels:DW 4600R/hr, Suppression Chamber 3160 R/hr, Outside plant less than 6R/hr (TEPCO 9pm 3/20/11)
Other electric power available, equipment testing in progress (JAIF, NISA, TEPCO)

ASSESMENT

Damaged fuel that fallen to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting seawater through the feed water system is cooling the vessel but with limited if any flow past the fuel. (b)(4),(b)(5) There is likely no water level inside the core barrel.

The fuel pool is slowly heating and has not reached saturation.

The primary containment is not damaged.

RECOMMENDATIONS

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units, 2100 March 23, 2011

UNIT TWO

STATUS

Core Status: damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling: seawater injection through RHR, bottom head temperature 105C, feed water nozzle temperature 105C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6)
Primary Containment: damage suspected (JAIF, NISA, TEPCO)
Secondary Containment: damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool: fuel covered, seawater injected on March 20, fuel pool temperature 51C (JAIF, NISA, TEPCO)
Rad Levels:
Other: External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESMENT

(b)(4),(b)(5)

Low level release path: fuel damaged, Reactor Coolant System breached at Recirculation pump seals, Primary containment damaged resulting in low level release. There is some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units, 2100 March 23, 2011

UNIT THREE

STATUS

Core Status: damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO)

(b)(4),(b)(5)

Core Cooling: seawater injection through RHR, bottom head temperature 225C, feed water nozzle temperature 304C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6)
Primary Containment: damage suspected (JAIF, NISA, TEPCO)
Secondary Containment: damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool: low water level, spraying with sea water (JAIF, NISA, TEPCO)
Rad Levels:
Other: External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESMENT

(b)(4),(b)(5)

Low level release path: fuel damaged, Reactor Coolant System breached at Recirculation pump seals, Primary containment damaged resulting in low level release. There is some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units, 2100 March 23, 2011

UNIT FOUR

STATUS

Core Status: offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling: not necessary (JAIF, NISA, TEPCO)
Primary Containment: not applicable (JAIF, NISA, TEPCO)
Secondary Containment: severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool: low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO)
Rad Levels:
Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool.

RECOMMENDATIONS

(b)(4),(b)(5)

~~OUO~~

RST Assessment of Fukushima Daiichi Units, 2100 March 23, 2011

UNIT FIVE

STATUS

Core Status: in vessel (JAIF, NISA, TEPCO)
Core Cooling: functional (JAIF, NISA, TEPCO)
Primary Containment: functional (JAIF, NISA, TEPCO)
Secondary Containment: vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool: fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other: External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT

Unit five is relatively stable

RECOMMENDATIONS

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

UNIT SIX

STATUS

Core Status: in vessel (JAIF, NISA, TEPCO)
Core Cooling: functional (JAIF, NISA, TEPCO)
Primary Containment: functional (JAIF, NISA, TEPCO)
Secondary Containment: vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool: fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other: External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT

Unit Six is relatively stable

RECOMMENDATIONS

Monitor

From:	Marshall, Jane
Sent:	Wednesday, April 06, 2011 1:14 PM
To:	(b)(6)
Subject:	Re: RST Assessments

Anytime. Forgot to note in the email that the files are OUO, but you already knew that.
Sent from my NRC Blackberry

From: Landau, Zachary L. (b)(6)
To: Marshall, Jane
Sent: Wed Apr 06 13:11:15 2011
Subject: RE: RST Assessments

You are the BEST – thanks much Jane.

Zach Landau
(b)(6)

From: Marshall, Jane [mailto:Jane.Marshall@nrc.gov]
Sent: Wednesday, April 06, 2011 1:04 PM
To: Landau, Zachary L.
Subject: FW: RST Assessments

Zach –

A couple of versions for you – first the 3/26 (Rev 0) version of the RST assessment, which we believe the NY Times article refers to, and the 3/31 Rev 1 version, which reflects more current thinking.

As a heads up these documents were developed over a period of time so there are other versions, with different time stamps. It is possible the NYT got a different version. However, these were the final versions of each Revision.

If you have any questions, please let me know

Jane

From: Powell, Amy
Sent: Thursday, April 07, 2011 2:58 PM
To: Batkin, Joshua
Subject: FW: RST Assessemnts
Attachments: 03-26-2100 Final RST assessment of Daiichi Units document.docx; 03-31-11 1200 RST Assessment Document REV 1 .docx

From: LIA06 Hoc
Sent: Wednesday, April 06, 2011 12:37 PM
To: Powell, Amy; Schmidt, Rebecca; Burnell, Scott
Cc: LIA08 Hoc
Subject: FW: RST Assessemnts

Attached are the 3/26 (Rev 0) version of the RST assessment, which we believe the NY Times article refers to, and the 3/31 Rev 1 version.

As a heads up these documents were developed over a period of time so there are other versions, with different time stamps. It is possible the NYT got a different version. However, these were the final versions of each Revision.

(b)(5) [redacted]

Tom Bergman
Liaison Team Director
U.S. Nuclear Regulatory Commission
Operations Center

From: RST01 Hoc
Sent: Wednesday, April 06, 2011 12:13 PM
To: LIA06 Hoc
Cc: RST06 Hoc; RST01B Hoc
Subject: RE: RST Assessemnts

As Requested
RST Coordinator

From: LIA06 Hoc
Sent: Wednesday, April 06, 2011 11:14 AM
To: RST01 Hoc
Cc: RST06 Hoc; RST01B Hoc
Subject: RE: RST Assessemnts

This does not match the hard copy version that has been shared within the Ops Center. The version we believe has been widely shared is dated 2100 hrs 3/26/2011, and was the version referred to by Pat Castleman during the 10 am call this morning. The version attached to your email is dated 0600 3/26/2001.

Similarly, the Rev 1 version is dated 1200 hrs 3/31, and is an actual revision to the document. The Rev 1 we have in hardcopy is more of an amendment, one page, and with no date stamp.

As we have been asked to provide these to OCA to provide to Congressional staff, and potentially to others, we need to make sure we are all working from the same versions. Please verify the versions of Rev 0 (believe 2100 is correct, and need a copy if so) and Rev 1 you sent are the correct versions.

Thanks

Tom Bergman
Liaison Team Director
U.S. Nuclear Regulatory Commission
Operations Center

From: RST01 Hoc
Sent: Wednesday, April 06, 2011 10:55 AM
To: LIA06 Hoc
Cc: RST06 Hoc; RST01B Hoc
Subject: RST Assessemnts

The redline assessment from May 26 th
and
the May 31 Rev 1 of the assessment
are attached.

RST Coordinator

(b)(5)

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RST Assessment of Fukushima Daiichi Units,

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

0600~~1400~~ EDT March 25~~6~~, 2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT ONE

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL). Vessel temperatures 149C at bottom drain, 197C at FW nozzle (NISA 1800 JDT 3/25) RPV at 65.7 psig (increasing trend), DW and torus pressure at 40 psig (decreasing trend) (NISA 1800 JDT 3/25).
Core Cooling:	Fresh water injection initiated at 1537 hrs JDT 3/25, injecting through feedwater 120l/min or 31.7 g/m (NISA) Recirculation pump seals have likely failed. (GEH) ; Expect to go to freshwater late on 3/25
Primary Containment:	Not damaged, 40 psia (TEPCO is~~was~~ considering venting ~~on 3/24~~) Drywell and Torus hydrogen and oxygen concentrations are unknown
Secondary Containment:	Severely damaged (hydrogen explosion)
Spent Fuel Pool:	Fuel covered, no seawater injected (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)
Rad levels:	DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant: 26mR/hr at gate (variable) (INPO 0900 hrs 3/25/11)
Other:	Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1 & U-3. Reactor water is in the Turbine Building basement (NISA)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited any flow past the fuel. (b)(4),(b)(5)

(b)(4),(b)(5) There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI. Naval Reactors (with Bettis and KAPL), and DOE/NE
0600~~1400~~ EDT March 25~~6~~, 2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

RECOMMENDATIONS:

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- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert (b)(6)
  - Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)

- (b)(4),(b)(5)
  - (b)(4),(b)(5) Containment spray should be secured before 2 psia. to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
  - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
C6001400 EDT March 256, 2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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UNIT TWO

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO).
	(b)(4),(b)(5)
Core Cooling:	~~Seawater injection through RHR via fire water~~ Fresh water with boric acid injection (TEPCO), bottom head temperature 104C, feed water nozzle temperature 107C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed (b)(6) ndustry) ~~Expect to go to freshwater late on 3/25~~
Primary Containment:	Damage suspected (JAIF, NISA, TEPCO)
Secondary Containment:	Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)
Spent Fuel Pool:	Fuel covered, seawater injected on March 20, fuel pool temperature 52C (JAIF, NISA, TEPCO 1800 JDT 3/25/11)
Rad Levels:	Drywell 4560 R/hr; Torus 154 R/hr (source instruments unknown); Outside plant: 26mR/hr at gate (variable) (b)(6) ~~0900 hrs 3/25/11~~ ndustry)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) ~~w~~Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RPV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

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Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:

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-

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(b)(4),(b)(5)

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- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert. (b)(6)

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  - Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)

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- Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen (b)(6)

(b)(4),(b)(5)

- o (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.

(b)(4),(b)(5)

- o When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
  - o Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	Freshwater injection via fire line initiated 1802 JDT 3/25/11 (NISA)~~Seawater injection through RHR~~, bottom head temperature 111C, feed water nozzle temperature Unreliable (JAIF, NISA 1800 JDT 3/25/11, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go freshwater cooling late on 3/25
Primary Containment	Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), spraying and pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 5100 R/hr, torus 150 R/hr (b)(6) ~~0900 3/25/11 Call source instruments unknown~~Industry); Outside plant: 26mR/hr at gate (variable) (b)(6) ~~0900 hrs 3/25/11~~Industry); 100 R/hr debris outside Rx building (covered).
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(6) ~~w~~Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RPV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

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Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4) (b)(6)
Unit 3 turbine building basement is flooding. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). (b)(4),(b)(5) (b)(4),(b)(5) Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS:

(b)(4),(b)(5)

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- (b)(4),(b)(5)
- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert (b)(6)
  - Steam/condensing could jeopardize inert environment , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5)
  (b)(4),(b)(5) Containment spray should be secured before 2 psia to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
  - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible
- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

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UNIT FOUR

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly.(JAIF, NISA, TEPCO) Temperature is unknown (NISA) (b)(4),(b)(5) 3/24
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information ~~from TEPCO~~ of neutron ~~sources~~ emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

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UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning Temperature 37.9 C (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

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UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
06001400 EDT March 256, 2011

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ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

From:	Larsen, Carl B. (INPO) <(b)(6)>
Sent:	Thursday, March 31, 2011 11:57 AM
To:	RST01 Hoc; (b)(6) (GE Power & Water); Modeen, David
Cc:	Hawn, Randall S. (INPO); Zohner, Nathan L. (INPO); Bramblett, Jeff W.; Webster, Bill E (INPO)
Subject:	RST Assessment, Rev. 1 with Industry Comment
Attachments:	03-31-11 2200 RST Assessment Document REV 1 Updated.docx
Follow Up Flag:	Follow up
Flag Status:	Flagged

The attached document contains the industry's comments on the new additions to the first page. Our comments are highlighted in green.

Thanks,
Carl Larsen
INPO ERC Technical Coordinator

RST Assessment of Fukushima Daiichi Units (REV 1),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 hrs 3/30/2011

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(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units (REV 1),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

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(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.
The <u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.
The <u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Majority of core is probably contained in the reactor pressure vessel (RPV); TEPCO believes the reactor water level may be 63 inches below TAF. The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

Vessel temperatures and pressures:

131.2°C at bottom drain and 277.8 °C at FW nozzle (TEPCO 0700 JDT 3/30) (both decreasing trend) (TEPCO 0700 JDT 3/30). RPV at 70.2 psia (increasing trend), DW and torus pressure at 35 psia (decreasing trend) (TEPCO 0700 JDT 3/30).

Core Cooling: Currently fresh water injection with no boron, injecting through feedwater line at 133 l/min. Injection is from a temporary motor driven pump powered from a temporary diesel generator (TEPCO); Injection flow rate will be maintained above the minimum debris retention injection rate (MDRIR). Recirculation pump seals have likely failed. (GEH); Injection flow rate above MDRIR could not be maintained through core spray. Assume shutdown cooling system is not available.

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Not damaged, 35 psia. Drywell and Torus hydrogen and oxygen concentrations are unknown. [redacted] (b)(4),(b)(5) The status of the nitrogen purge capability is unknown. [redacted] An explosive mixture is possible.

Secondary Containment:

Severely damaged (hydrogen explosion).

Spent Fuel Pool:

The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)

Rad levels: DW 3710 R/hr, Torus 1900 R/hr (CAMS), Outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

Reactor water is in the Turbine Building basement (NISA). [redacted] (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. (b)(4),(b)(5) [redacted]

There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(5) [redacted] shows entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

2200 hrs 3/30/2011

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RECOMMENDATIONS: (for consideration to stabilize Unit 1)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5)

- Vent containment (b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.

(b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

Additional Considerations

A. The following considerations apply to containment venting:

RST Assessment of Fukushima Daiichi Units (REV 1), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 hrs 3/30/2011

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1. (b)(4),(b)(5)
2.
3.
4. Spray water on steam plumes and planned containment vents for scrubbing effect and (b)(4),(b)(5)
5.

B. Additional Miscellaneous considerations

1. (b)(4),(b)(5)
2. Borate water if possible.
3. Ensure spent fuel pool level is maintained as full as possible.
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5)
5. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)

4.
5. (b)(4),(b)(5)

UNIT TWO

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Majority of core is probably contained in the reactor vessel. Reactor water level may be 59 inches below TAF (TEPCO). (b)(4),(b)(5)

Core Cooling: Freshwater injection via injection of non-borated fresh water using the low pressure coolant injection (LPCI) continues. Injection is from a temporary motor driven pump powered from a temporary diesel generator (3/29/11 TEPCO). Flow rate 117 l/min. Bottom head temperature 131.6 C, feed water nozzle temperature 172.4 C (TECPO 0700 3/30/11)) Recirculation pump seals have likely failed. (Industry)

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

Drywell pressure reading 14.5 psia (3/30/11 TEPCO)

Secondary Containment:

Damaged (JAIF, NISA, TEPCO), steam or vapor can be seen coming from the blowout panel in the reactor building (b)(5)

Spent Fuel Pool:

Freshwater being injected directly into the spent fuel pool as of 3/29/11 (TEPCO) using a pump supplied from off-site power. The Unit 2 spent fuel pool is as 46 degrees centigrade or 115 degrees Fahrenheit. TEPCO believes the Fuel is covered.

Rad Levels: Drywell 3999 R/hr; Torus 128 R/hr (CAMS);

Outside plant: 11 mR/hr at gate (variable) (TEPCO 0700 JDT 3/30)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. Technicians are continuing to check DC distribution panels.

ASSESSMENT:

Damaged fuel may have slumped with the majority located on the core plate and fuel in the lower region of the core is likely encased in salt. However, the amount of salt build-up appears to be less than U-1 based on the reported lower temperatures. (b)(4),(b)(5) Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling flow is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

The primary containment is damaged

**RST Assessment of Fukushima Daiichi Units (REV 1),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE**

2200 hrs 3/30/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT 2

RECOMMENDATIONS: (for consideration to stabilize Unit 2)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5)
  a. (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)

(b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.5. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)

d. (b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.4 below)

Additional Considerations

A. The following considerations apply to containment venting:

1.

2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5)
(b)(4),(b)(5)

a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) uction pressure and Drywell instrument taps
b. Radiation monitoring instruments (b)(4),(b)(5)
c.
d. (b)(4),(b)(5)
e.

UNIT THREE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Majority of core is probably contained in reactor vessel; (b)(4),(b)(5) TEPCO believes the reactor water level is 79 inches below TAF. (b)(4),(b)(5)

Core Cooling: Freshwater injection via injection of non-borated fresh water injection using the low pressure coolant injection (LPCI) continues. Injection is from a temporary motor driven pump powered from a temporary diesel generator (3/29/11 TEPCO). Bottom head temperature 116 C, feed water nozzle temperature Unreliable (0800 3/30/11 TEPCO) Recirculation pump seals have likely failed.

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)

Drywell pressure 15.53 psia, Torus pressure 25.82 psia (0800 3/30/11 TEPCO)

Secondary Containment

Damaged (JAIF, NISA, TEPCO)

Spent Fuel Pool

Unknown temperature and water level (TEPCO) freshwater is being sprayed as needed using a cement truck.

Rad Levels: DW 2760 R/hr, torus 111 R/hr (3/30/11 TEPCO);

Outside plant: 11 mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: External AC power has reached the unit, checking integrity of equipment before energizing. In Unit 3, lighting distribution panels are being checked.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Water injection is to the RPV through the RHR system via the recirculation piping, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement has flooded. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

2200 hrs 3/30/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT 3

RECOMMENDATIONS: (for consideration to stabilize Unit 3)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5)
  a. core spray
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)

- (b)(4),(b)(5)
-
-

- Vent containment: (see Additional Considerations A.1. through A.8. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.

c.
d. (b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
(b)(4),(b)(5)
3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5)
   a. HPCI suction pressure and Drywell instrument taps
   b. Radiation monitoring instruments (b)(4),(b)(5)
   c.
   d. (b)(4),(b)(5)

UNIT FOUR

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)

Core Cooling: Not necessary (JAIF, NISA, TEPCO)

Primary Containment:
Not applicable (JAIF, NISA, TEPCO)

Secondary Containment:
Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature is unknown (NISA).

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

1. Maintain coverage of spent fuel pool with fresh borated water.
2. As possible, put spent fuel cooling and cleanup in service.

UNIT FIVE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: In vessel (JAIF, NISA, TEPCO)

Core Cooling: Functional (JAIF, NISA, TEPCO)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Fuel pool cooling functioning Temperature 37.9 C (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

2200 hrs 3/30/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT SIX

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: In vessel (JAIF, NISA, TEPCO)

Core Cooling: Functional (JAIF, NISA, TEPCO)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

From: OST01 HOC
Sent: Sunday, March 27, 2011 3:12 PM
To: ET07 Hoc; PMT02 Hoc; PMT11 Hoc; Hoc, PMT12
Cc: FOIA Response.hoc Resource
Subject: FW: Japan Radiological Data
Attachments: Japan_Combined_Survey_Data_27_MAR_1200_EDT.xlsx

Please forward, if necessary.

-----Original Message-----
From: HOO Hoc [mailto:HOO.Hoc@nrc.gov]
Sent: Sunday, March 27, 2011 1:50 PM
To: LIA07 Hoc; OST01 HOC; OST02 HOC; OST03 HOC
Subject: FW: Japan Radiological Data

From: NITOPS[SMTP:NITOPS@NNSA.DOE.GOV]
Sent: Sunday, March 27, 2011 1:50:06 PM
To: DL-Policy Working Group; CMHT; HOO Hoc; NARAC; PMT01 Hoc; PMT02 Hoc; Hoc, PMT12
Cc: NITOPS
Subject: FW: Japan Radiological Data
Auto forwarded by a Rule

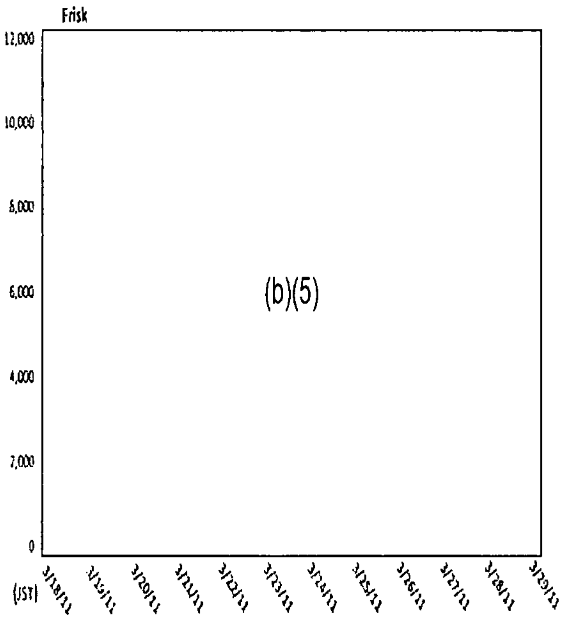
-----Original Message-----
From: Naples, Elmer M SES SEA 08 NR [mailto (b)(6)
Sent: Sunday, March 27, 2011 1:45 PM
To: (b)(6)
Subject: FW: Japan Radiological Data

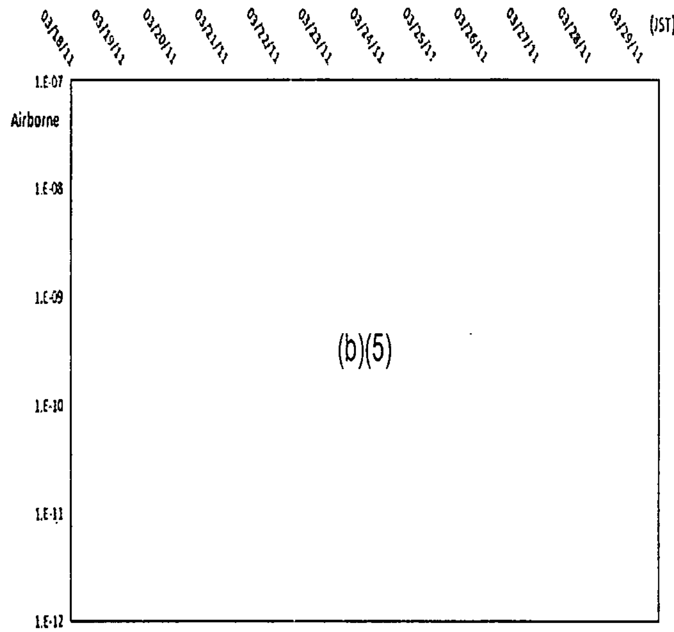
Attached is the daily update of Navy radiological survey data dated 3/27/11. Please note the Ishioka team moved to Mito after 0700 on 27 March 2011 JST. Mito is 15 miles closer to Fukushima; they moved due to increased traffic in Ishioka associated with reopening of a train station.

V/R,
Elmer Naples
Naval Reactors

Nanaban Tower: LAT. 35.29N, LONG. 139.67E

Yokosuka





Date and Time	Date and Time2	Radiation	Frisk	PAS	RI	Notes	Isotopic Analysis						
							I-131	I-132	Cs-134	Cs-136	Cs-137	Te-132	Tc-99m
(EDT)	(JST)	(mr/hr)	(pCi/probe)	(µCi/mL)	(µCi/mL)		(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)

(b)(5)

(b)(5)

(b)(5)

(b)(5)

(b)(5)

(b)(5)

(b)(5)

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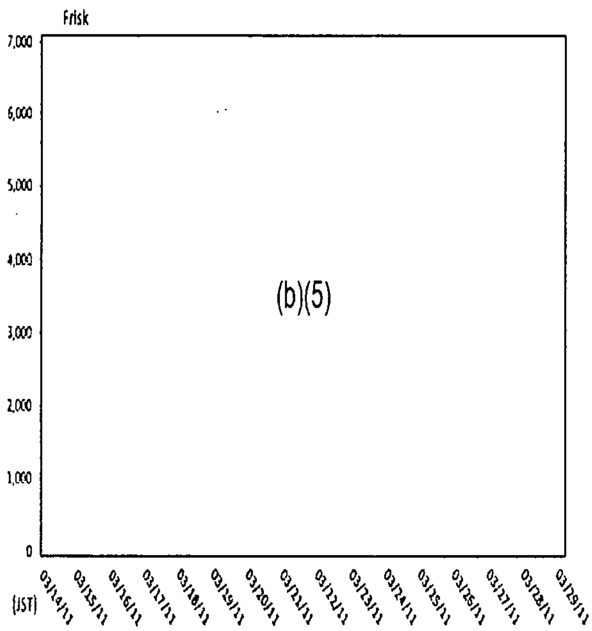
(b)(5)

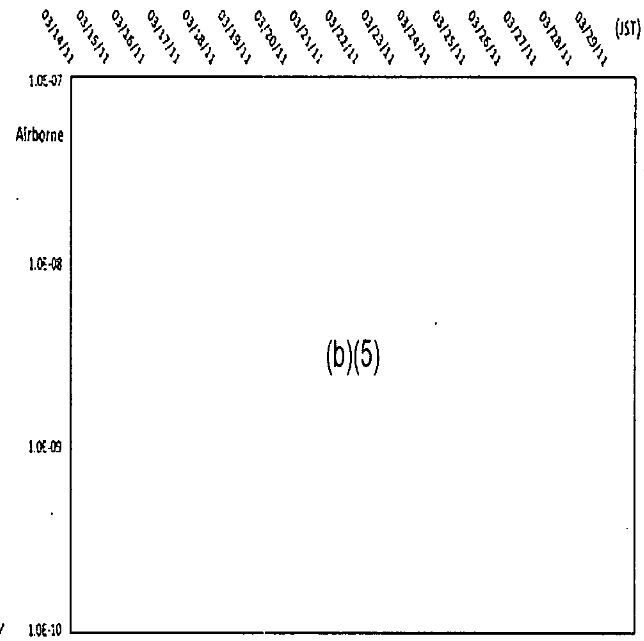
Notes

(b)(5)

Atsugi NAS: LAT 35.42N, LONG. 139.36E

Northwest of Yokosuka





Date and Time	Date and Time2	Radiation	Frisk	PAS	RI	Notes	Isotopic Analysis						
							I-131	I-132	Cs-134	Cs-136	Cs-137	Te-132	Tc-99m
(EDT)	(JST)	(mr/hr)	(uCi/probe)	(µCi/mL)	(µCi/mL)		(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)
(b)(5)													

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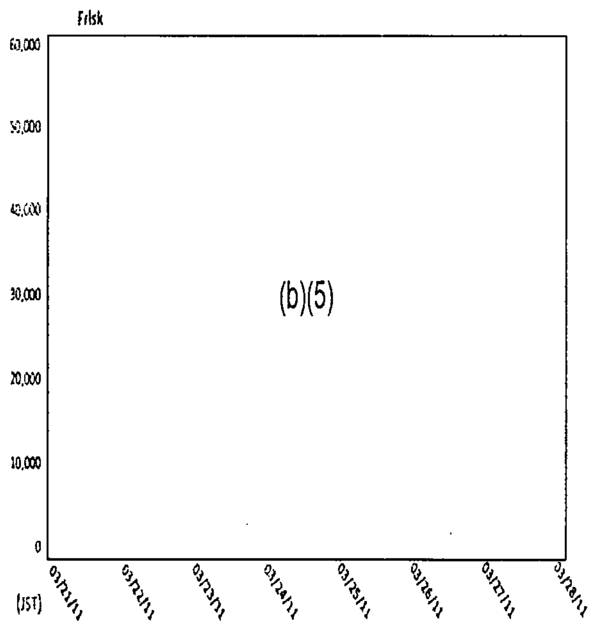
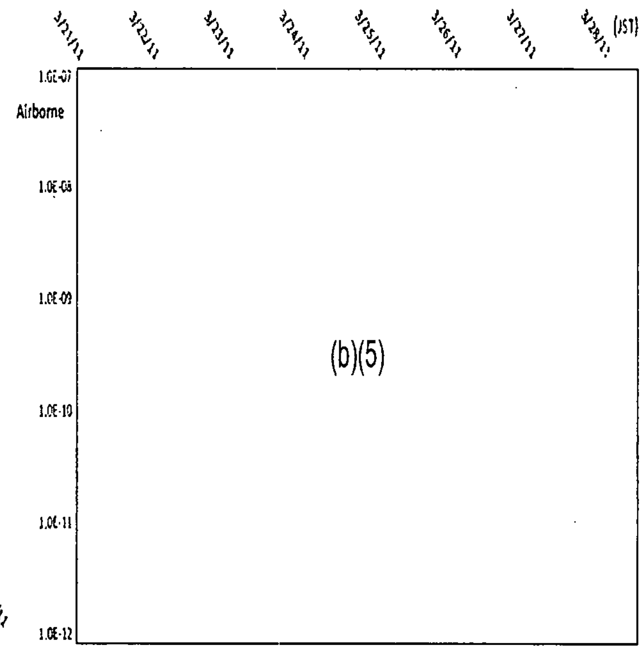
Notes

(b)(5)

Ishioka (North Advance Team): LAT. 36.18N, LONG. 140.27E

55nm N of Yokosuka, 93nm S of Fukushima





Date and Time (EDT)	Date and Time2 (JST)	Radiation (mr/hr)	Frisk (pCi/probe)	PAS (µCi/mL)	RI (µCi/mL)	Notes	Isotopic Analysis I-131 (µCi/mL)	I-132 (µCi/mL)	Cs-134 (µCi/mL)	Cs-136 (µCi/mL)	Cs-137 (µCi/mL)	Te-132 (µCi/mL)	Tc-99m (µCi/mL)

(b)(5)

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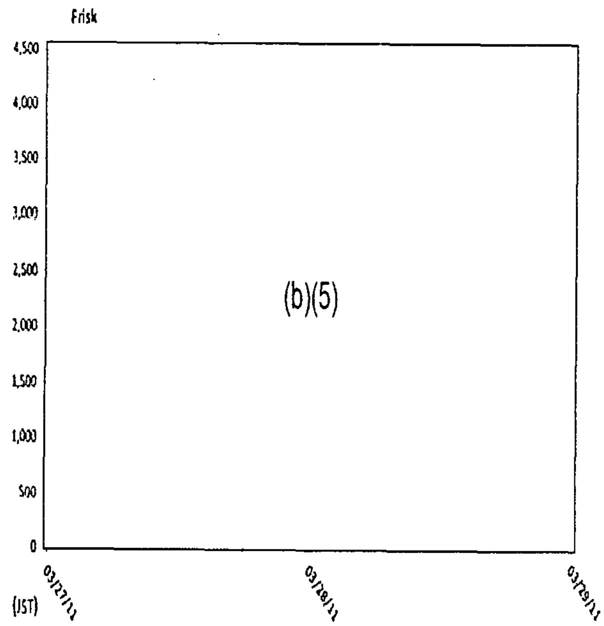
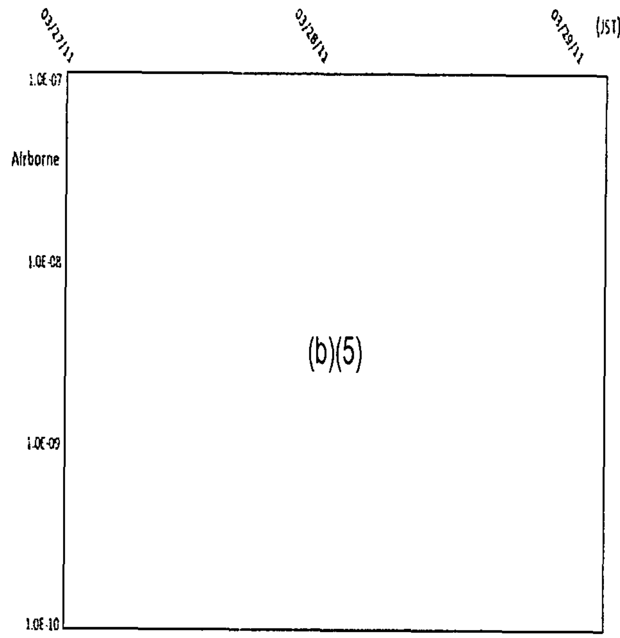
Notes

(b)(5)

Mito: LAT. 36.3710N, LONG. 140.4762E (Team Previously Located @ Ishioka)

Northeast of Ishioka





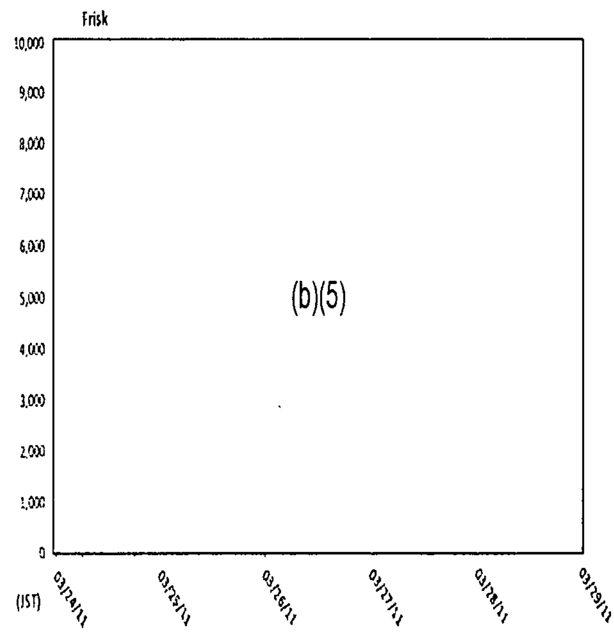
							Isotopic Analysis						
Date and Time	Date and Time2	Radiation	Frisk	PAS	RI	Notes	I-131	I-132	Cs-134	Cs-136	Cs-137	Te-132	Tc-99m
(EDT)	(JST)	(mr/hr)	(pCi/probe)	(µCi/mL)	(µCi/mL)		(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)
(b)(5)													

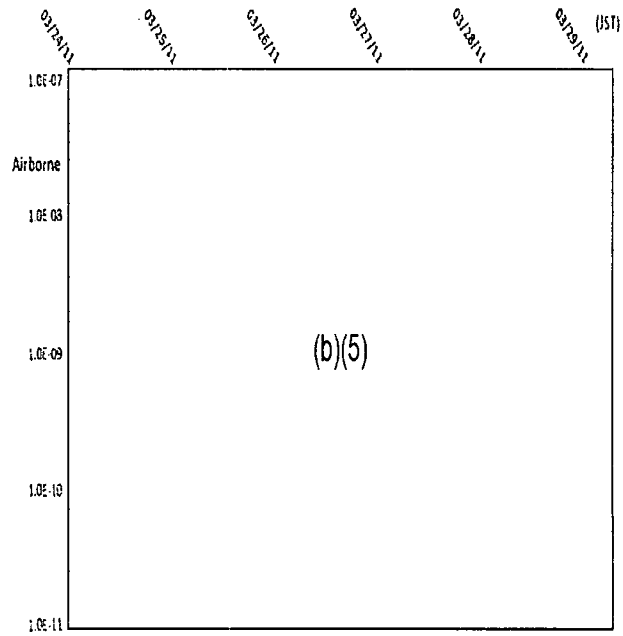
(b)(5)

Notes

Tsukuba: LAT. 36.04N, LONG. 140.06E

~60 miles north-east of Yokosha and 106 miles south of Fukushima





Date and Time	Date and Time2	Radiation	Frisk	PAS	RI	Notes	Isotopic Analysis						
							I-131	I-132	Cs-134	Cs-136	Cs-137	Te-132	Tc-99m
(EDT)	(JST)	(mr/hr)	(pCi/probe)	(µCi/mL)	(µCi/mL)		(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)	(µCi/mL)

(b)(5)

(b)(5)

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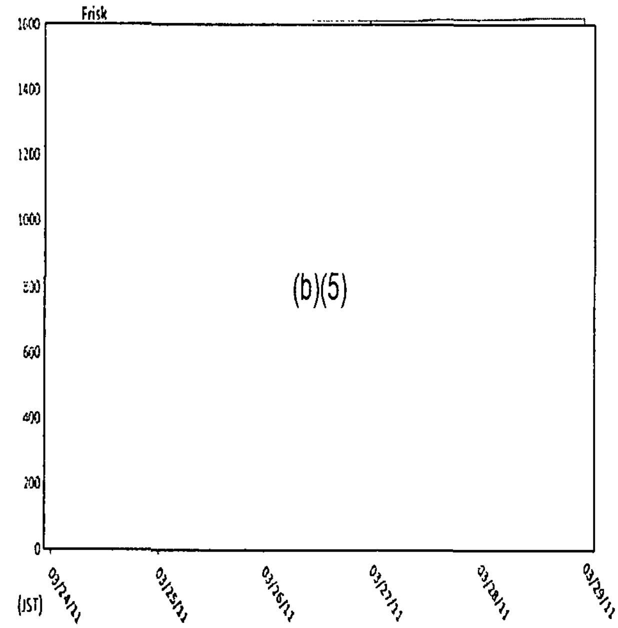
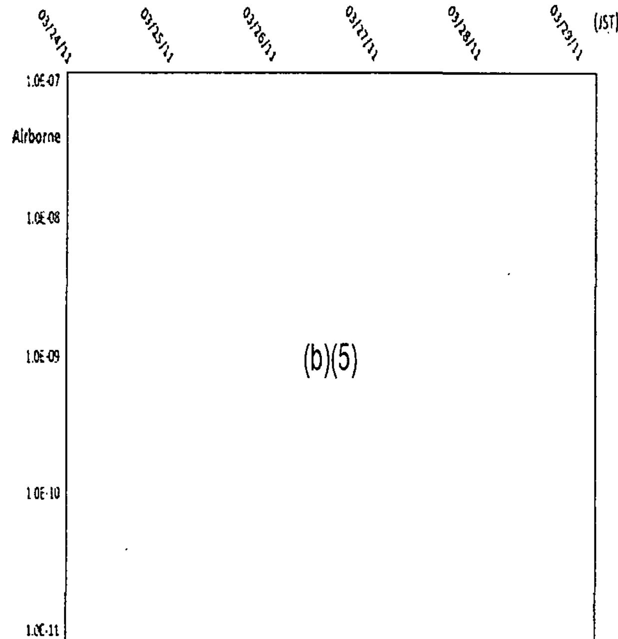
Notes

(b)(5)

Oyama: LAT. 36.2975N, LONG. 139.82199E

~72 miles north of Yokosuka and 100 miles south of Fukushima





Date and Time	Date and Time2	Radiation	Frisk	PAS	RI	Notes	I-131	I-132	Cs-134	Cs-136	Cs-137	Te-132	Tc-99m
							Isotopic Analysis						
(EDT)	(JST)	(mr/hr)	(pCi/probe)	(μCi/mL)	(μCi/mL)		(μCi/mL)	(μCi/mL)	(μCi/mL)	(μCi/mL)	(μCi/mL)	(μCi/mL)	(μCi/mL)

(b)(5)

(b)(5)

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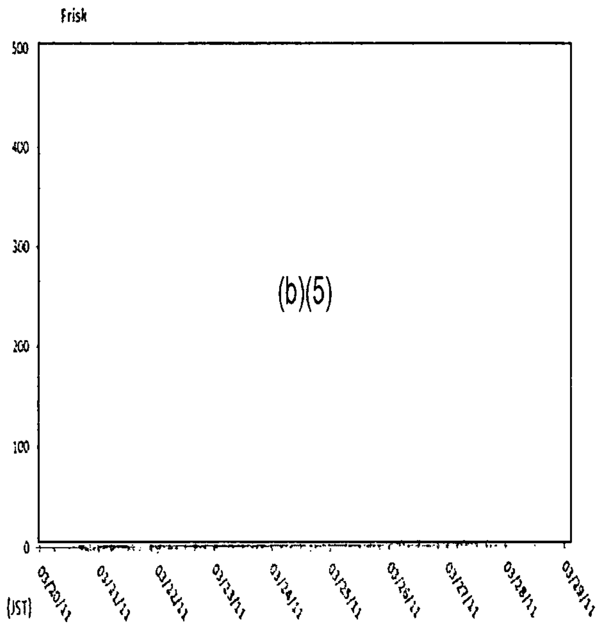
(b)(5)

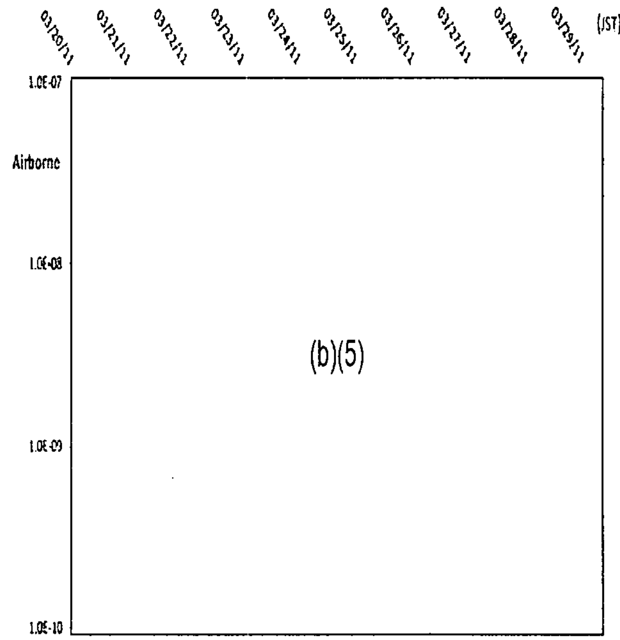
(b)(5)

Notes

(b)(5)

Misawa NAS: LAT. 40.71N, LONG. 141.37E





Date and Time (EDT)	Date and Time2 (JST)	Radiation (mr/hr)	Frisk (pCi/probe)	PAS (uCi/mL)	RI (uCi/mL)	Notes	Isotopic Analysis I-131 (µCi/mL)	I-132 (µCi/mL)	Cs-134 (µCi/mL)	Cs-136 (µCi/mL)	Cs-137 (µCi/mL)	Te-132 (µCi/mL)	Tc-99m (µCi/mL)
(b)(5)													

(b)(5)

(b)(5)

Notes

From: RST01 Hoc
Sent: Thursday, March 31, 2011 11:16 PM
To: (b)(6)
Cc: RST07 Hoc; RST01 Hoc
Subject: FW: Revision to Cover Memo for Rev 1 to the RST Assessment
Attachments: FW: USNRC REACTOR SAFETY TEAM ASSESSMENT REV 1

Importance: High

All,

Please note that the revision to the cover memo (see below) still applies to the Rev1 of the RST Assessment which was distributed at 7:10 on 3/31/2011 (See Attached).

Thanks,

Greg
RST Coordinator

From: RST08 Hoc
Sent: Thursday, March 31, 2011 2:16 PM
To: RST01 Hoc
Subject: Revision to Cover Memo for Rev 1 to the RST Assessment

Revision 1 to the RST assessment is attached. This revision accomplishes two principal objectives:

(b)(5)

(b)(5)

Bano, Mahmooda

From: Scott, Michael
Sent: Thursday, March 31, 2011 7:59 PM
To: 'nei-hisanori@meti.go.jp'
Cc: RST01 Hoc
Subject: RST Assessment REV 1
Attachments: 03-31-11 1200 RST Assessment Document REV 1 .pdf

Dear Nei-san:

Please find attached the latest revision to the NRC consortium's evaluation and recommendations regarding the Fukushima Daiichi reactors and spent fuel pools. We look forward to discussing this document with you when you wish, perhaps at today's 1100 meeting.

Regards,

Mike Scott
NRC Japan team

From: Emche, Danielle
Sent: Thursday, March 31, 2011 5:55 PM
To: LIA03 Hoc; English, Lance
Cc: Abrams, Charlotte; LIA02 Hoc
Subject: Re: TAIWAN

(b)(5)

Danielle
Sent from an NRC BlackBerry.

From: LIA03 Hoc
To: English, Lance
Cc: Abrams, Charlotte; Emche, Danielle; LIA02 Hoc
Sent: Thu Mar 31 17:43:47 2011
Subject: RE: TAIWAN

Mr. Huang called this evening (3/31). There is no urgency to set up the conference call, and he will call at a later time to set up the date. But he said he would like to start the conference call with a briefing from PMT/RST on the technical status of Fukushima as RST and PMT understands it and then he will ask questions.

From: LIA03 Hoc
Sent: Wednesday, March 30, 2011 3:27 PM
To: English, Lance
Cc: Abrams, Charlotte
Subject: TAIWAN

Hi Lance,

FYI as the Taiwan backup and per Danielle's request, arrangements are underway for the PMT to set up a teleconference with Taiwan (b)(5) No time/date has been set yet – I just checked with the PMT. I am on till 11 tonight and will listen in as the OIP liaison. If there are any follow-up actions for you as backup desk officer, I'll get back to you.

Gerri

From: Wiggins, Jim
Sent: Thursday, March 31, 2011 2:43 PM
To: Grant, Jeffery; ET07 Hoc
Subject: Fw: For you awareness: RASCAL source term issue from last Sat nite/Sun AM -

Importance: High

For IR lessons learned.

From: Jones, Cynthia
To: Uhle, Jennifer
Cc: Evans, Michele; Wiggins, Jim
Sent: Thu Mar 31 13:40:27 2011
Subject: For you awareness: RASCAL source term issue from last Sat nite/Sun AM -

Jennifer-

(b)(5)

Cyndi

From: Jones, Cynthia
Sent: Thursday, March 31, 2011 1:34 PM
To: Brandon, Lou
Cc: 'atheyconsulting@frontiernet.net'; Sullivan, Randy
Subject: FW: RASCAL issue from
Importance: High

Lou-

(b)(5)

(b)(5)

Thanks
Cyndi

From: PMT02 Hoc
Sent: Saturday, March 26, 2011 10:46 PM
To: 'atheyconsulting@frontiernet.net'
Cc: Brandon, Lou
Subject: RASCAL issue
Importance: High

George,

(b)(5)

Please test this and correct the RASCAL model appropriately.

Lou

PMT Dose Analyst (PMT02)
NRC Operation Center

THIS IS A DRILL --- THIS IS A DRILL --- THIS IS A DRILL

From:	Fonner, Susan
To:	Haney, Catherine; Johnson, Michael; Leeds, Eric
Cc:	Hirsch, Patricia; Crockett, Steven
Subject:	Markey bill on nuclear power plant safety.doc
Date:	Thursday, March 31, 2011 4:14:33 PM
Attachments:	Markey bill on nuclear power plant safety.doc

For your information, attached is a bill that Congressman Markey hopes will be taken up for consideration in the House of Representatives. It is clearly informed by the disastrous events that occurred in Japan earlier this month. The bill would require the NRC to revise regulations that are relevant to the safety of nuclear power plants and spent fuel storage. Among other things, the bill would require the Commission to refrain from approving any construction permit, operating license, license extension, design certification, combined license, design approval, or manufacturing license until the regulations that would be mandated by the bill take effect.

In addition, the bill would amend section 1702(b) of the Energy Policy Act of 2005, which sets forth terms and conditions for making loan guarantees for certain eligible projects (listed in section 1703 of the Act), including advanced nuclear energy facilities. The amendment would provide that in the case of advanced nuclear energy facilities, the Secretary of Energy would be required to ensure that the cost of the obligation is calculated using a consideration of the Tohoku earthquake of 2011 (i.e., the earthquake that was the source of so much damage to Japan) to estimate the risk characteristics of the project.

OGC analyzes and comments on bills of interest to the NRC. The fate of the Markey bill is currently uncertain, but given the strong interest in this country about events in Japan, it would be worthwhile for your office to review this bill, and to apprise my office of your views on the proposed amendments.

In reading the attached bill, you may see that some of the pages have a series of diagonal lines following text of the bill. The diagonal lines are a signal that the text continues on the next page. Also, you may see some short colored lines now and then under words; ignore those lines. These strange signs are the result of difficulty I had in transferring the bill to a WORD document, but the entire text of the bill should be there.

If there are any questions, please call me at 415-1629 or Steven Crockett at 415-2871. (I will not be in the office on Friday, April 1, but will be back on Monday, April 4.)

(Original Signature of Member)

112TH CONGRESS
1ST SESSION

H. R. ______

To ensure that nuclear power plants can withstand and adequately respond to earthquakes, tsunamis, strong storms, or other events that threaten a major impact.

IN THE HOUSE OF REPRESENTATIVES

Mr. MARKEY introduced the following bill; which was referred to the Committee on______________________________

A BILL

To ensure that nuclear power plants can withstand and adequately respond to earthquakes, tsunamis, strong storms, or other events that threaten a major impact.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Nuclear Power Plant Safety Act of 2011".

SEC. 2. NUCLEAR POWER PLANT SAFETY.

(a) AMENDMENT.—Chapter 14 of the Atomic Energy Act of 1954 (42 U.S.C. 2201 et seq.) is amended by adding at the end the following new section:

"SEC. 170J. REVISION OF NUCLEAR POWER PLANT SAFETY REGULATIONS.—

"a. Not later than 90 days after the date of enactment of the Nuclear Power Plant Safety Act of 2011, the Commission shall initiate a rulemaking proceeding, including notice and opportunity for public comment, to be completed not later than 18 months after such date of enactment, to revise its regulations to ensure that each utilization facility licensed under this Act can withstand and adequately respond to—

"(1) an earthquake, tsunami (for a facility located in a coastal area), strong storm, or other event that threatens a major impact to the facility;

"(2) a loss of the primary operating power source for at least 14 days; and

"(3) a loss of the primary backup operating power source for at least 72 hours.

"b. The revision of regulations under this section shall provide for—

"(1) a requirement that each licensed utilization facility, including any onsite spent nuclear fuel facilities, be equipped with resilient containment, safety, and diagnostic systems sufficient to withstand the circumstances described in subsection a., including requirements to ensure that the reactor core remains cooled, that the containment remains intact, and that the spent fuel cooling and spent fuel pool integrity are maintained;

"(2) a requirement that licensees have at least 14 days worth of emergency power system fuel onsite with which to power the licensed facility in the event of a loss of the primary operating power source;

"(3) a requirement that licensees have sufficient secondary emergency power to power the licensed facility in the event of a loss of both the primary operating power source and the emergency power system described in paragraph (2) for at least 72 hours;

"(4) a requirement that licensees develop, and obtain approval from the Commission for, a plan to obtain sufficient additional fuel or batteries in the event of a long duration loss of operating power or total station blackout;

"(5) a requirement that licensees amend, and obtain approval from the Commission for, any guidance and strategies developed by the licensees that are intended to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant due to explosions or fire, in order to incorporate lessons learned from the Fukushima nuclear power plant meltdown into such guidance and strategies;

"(6) a requirement that spent nuclear fuel rods be moved from storage pools to certified dry cask storage within one year of the nuclear fuel rods being qualified to be placed in the certified dry casks;

"(7) a requirement to configure spent nuclear fuel rods in spent nuclear fuel pools in a manner that would minimize the chance of a fire in the event of the loss of the water in the spent nuclear fuel pool;

"(8) a requirement that emergency response exercises include scenarios that are based on the near-simultaneous occurrence of circumstances described in subsection a. such as the near-simultaneous earthquake, tsunami, and total station blackout that occurred at the Fukushima nuclear power plant in 2011; and

"(9) appropriate requirements for periodic verification of compliance with the regulations issued under this section.

"c. The Commission shall not issue an approval for any construction permit, operating license, license extension, design certification, combined license, design approval, or manufacturing license until the revisions of regulations under this section take effect.".

(b) CONFORMING AMENDMENT.—The table of contents of the Atomic Energy Act of 1954 is amended by inserting after the item relating to section 170I the following new item:

"Sec. 170J. Revision of nuclear power plant safety regulations.".

SEC. 3. LOAN GUARANTEES.

Section 1702(b) of the Energy Policy Act of 2005 (42 U.S.C. 16512(b)) is amended by inserting after paragraph (2) the following:

"In the case of a guarantee for advanced nuclear energy facilities, the Secretary shall ensure that the cost of the obligation is calculated using a consideration of the Tohoku earthquake of 2011 to estimate the risk characteristics of the project.".

From: LIA06 Hoc
Sent: Thursday, March 31, 2011 7:18 PM
To: Bradford, Anna
Subject: RE: ACTION - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

Roger that. Thank you. I just wanted to make sure so we hit all the points tonight.

Mark Lombard
Liaison Team Director
U.S. Nuclear Regulatory Commission
Operations Center

From: Bradford, Anna
Sent: Thursday, March 31, 2011 7:17 PM
To: LIA06 Hoc
Subject: Re: ACTION - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

Hi Mark,

(b)(5)

Anna Bradford
Chairman Jaczko's Office
US Nuclear Regulatory Commission

From: LIA06 Hoc
To: Bradford, Anna
Sent: Thu Mar 31 18:48:30 2011
Subject: FW: ACTION - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

Anna,

(b)(5)

Thanks,

Mark Lombard
Liaison Team Director
U.S. Nuclear Regulatory Commission
Operations Center

From: Weber, Michael
Sent: Thursday, March 31, 2011 6:26 PM

To: Sheron, Brian; Thaggard, Mark
Cc: LIA06 Hoc; LIA08 Hoc; ET01 Hoc; ET05 Hoc; OST02 HOC; Bradford, Anna
Subject: ACTION - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC
Importance: High

(b)(5)

Thanks

From: Bradford, Anna
Sent: Thursday, March 31, 2011 6:10 PM
To: Weber, Michael; Borchardt, Bill; HOO Hoc
Cc: Pace, Patti; Batkin, Joshua; Coggins, Angela
Subject: FW: FYI - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC
Importance: High

Bill and Mike,

(b)(5)

Thanks!

Anna Bradford
Policy Advisor for Nuclear Materials
Office of Chairman Jaczko
U.S. Nuclear Regulatory Commission
301-415-1827

From: Coggins, Angela
Sent: Thursday, March 31, 2011 4:41 PM
To: Bradford, Anna
Subject: Fw: FYI - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

Angela Coggins
Policy Director
Office of Chairman Gregory B Jaczko
US Nuclear Regulatory Commission
angela.coggins@nrc.gov/301-415-1828

From: Weber, Michael
To: Jaczko, Gregory
Cc: Coggins, Angela; Batkin, Joshua; Borchardt, Bill; Burns, Stephen; Doane, Margaret; Mamish, Nader
Sent: Thu Mar 31 16:16:13 2011
Subject: FYI - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

(b)(5)

If you need any additional information, please advise.

From: Lewis, Robert
Sent: Thursday, March 31, 2011 3:12 PM
To: Milligan, Patricia; Weber, Michael; Wiggins, Jim; Moore, Scott; Virgilio, Martin; Haney, Catherine; Ordaz, Vonna; Evans, Michele; Cool, Donald; DeCicco, Joseph; Reis, Terrence; Luehman, James; Zimmerman, Roy; McDermott, Brian; Brock, Kathryn; Deegan, George; Cook, John; Owens, Janice; Mamish, Nader; Rothschild, Trip; Doane, Margaret; PMT03 Hoc; PMT04 Hoc; PMT07 Hoc
Subject: FYI: Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

John Cook and I attended the "NATIONAL SECURITY STAFF, TRANSBORDER SECURITY INTERAGENCY POLICY COMMITTEE meeting on Supply Chain Security on Thursday March 31, 2011, in the White House Conference Center. The attached handout (same as yesterday was used for the meeting). Below is a summary.

(b)(5)

(b)(5)

From: Bradford, Anna
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(b)(5)

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(b)(5)

Thanks,

Mark Lombard
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Cc: LIA06 Hoc; LIA08 Hoc; ET01 Hoc; ET05 Hoc; OST02 HOC; Bradford, Anna
Subject: ACTION - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC
Importance: High

(b)(5)

(b)(5)

Thanks

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Subject: FW: FYI - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC
Importance: High

Bill and Mike,

(b)(5)

Thanks!

Anna Bradford
Policy Advisor for Nuclear Materials
Office of Chairman Jaczko
U.S. Nuclear Regulatory Commission
301-415-1827

From: Coggins, Angela
Sent: Thursday, March 31, 2011 4:41 PM
To: Bradford, Anna
Subject: Fw: FYI - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

Angela Coggins
Policy Director
Office of Chairman Gregory B Jaczko
US Nuclear Regulatory Commission
angela.coggins@nrc.gov/301-415-1828

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To: Jaczko, Gregory
Cc: Coggins, Angela; Batkin, Joshua; Borchardt, Bill; Burns, Stephen; Doane, Margaret; Mamish, Nader
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(b)(5)

(b)(5)

From: LIA06 Hoc
Sent: Thursday, March 31, 2011 6:50 PM
To: RST Communicator; Hoc, PMT12
Subject: FW: ACTION - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC
Attachments: Japan Supply Chain Document ver 29MAR.DOC

Importance: High

Liaison Team Director
U.S. Nuclear Regulatory Commission
Operations Center

From: Weber, Michael
Sent: Thursday, March 31, 2011 6:26 PM
To: Sheron, Brian; Thaggard, Mark
Cc: LIA06 Hoc; LIA03 Hoc; ET01 Hoc; ET05 Hoc; OST02 HOC; Bradford, Anna
Subject: ACTION - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC
Importance: High

(b)(5)

Thanks

From: Bradford, Anna
Sent: Thursday, March 31, 2011 6:10 PM
To: Weber, Michael; Borchardt, Bill; HOO Hoc
Cc: Pace, Patti; Batkin, Joshua; Coggins, Angela
Subject: FW: FYI - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC
Importance: High

Bill and Mike,

(b)(5)

Thanks!

Anna Bradford
Policy Advisor for Nuclear Materials
Office of Chairman Jaczko
U.S. Nuclear Regulatory Commission
301-415-1827

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Sent: Thursday, March 31, 2011 4:41 PM
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Subject: Fw: FYI - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

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Policy Director
Office of Chairman Gregory B Jaczko
US Nuclear Regulatory Commission
angela.coggins@nrc.gov/301-415-1828

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To: Jaczko, Gregory
Cc: Coggins, Angela; Batkin, Joshua; Borchardt, Bill; Burns, Stephen; Doane, Margaret; Mamish, Nader
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(b)(5)

From: LIA06 Hoc
Sent: Thursday, March 31, 2011 10:29 PM
To: Hoc, PMT12
Subject: FW: FYI - Background Briefing Material for Principals Committee Meeting
Attachments: Japan Supply Chain Document ver 29MAR.DOC; 2013e.pdf

Importance: High

FYI-further action needed.

Mark Lombard
Liaison Team Director
U.S. Nuclear Regulatory Commission
Operations Center

From: Weber, Michael
Sent: Thursday, March 31, 2011 10:20 PM
To: Sheron, Brian; Thaggard, Mark; ET01 Hoc; ET05 Hoc; LIA06 Hoc; LIA08 Hoc; OST02 HOC
Subject: FYI - Background Briefing Material for Principals Committee Meeting
Importance: High

More related to the Chairman's request for background information for tomorrow's meeting.

From: Pace, Patti
To: Weber, Michael; Burns, Stephen; Doane, Margaret; Borchardt, Bill
Cc: Batkin, Joshua; Coggins, Angela; Bradford, Anna
Sent: Thu Mar 31 20:37:33 2011
Subject: REQUEST: Background Briefing Material for Principals Committee Meeting

Good Evening,

(b)(5)

Many thanks,

Patti Pace

Assistant to Chairman Gregory B. Jaczko
U.S. Nuclear Regulatory Commission
301-415-1820 (office)
301-415-3504 (fax)

From: Weber, Michael
Sent: Thursday, March 31, 2011 4:16:13 PM
To: Jaczko, Gregory
Cc: Coggins, Angela; Batkin, Joshua; Borchardt, Bill; Burns, Stephen; Doane, Margaret; Mamish, Nader
Subject: FYI - Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

(b)(5)

If you need any additional information, please advise.

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(b)(5)

(b)(5)

INFO PAPER

Purpose

(b)(5)

Background

(b)(5)

(b)(5)

Additional Information Necessary:

(b)(5)

Discussion

(b)(5)

(b)(5)

Policy Issues:

(b)(5)

(b)(5)

(b)(5)

NATIONAL SECURITY STAFF
WASHINGTON, D.C. 20504

March 30, 2011

(b)(5),(b)(6)

Attachment
Tab A Agenda

Tab A

PRINCIPALS COMMITTEE MEETING ON JAPAN

DATE: April 1, 2011
LOCATION: White House Situation Room
TIME: 11:00 a.m. - 12:30 p.m.

AGENDA

I.

II.

III.

IV.

V.

VI.

VII.

(b)(5)

Cronk, Kevin

From: LIA02 Hoc
Sent: Thursday, March 31, 2011 4:29 PM
To: Liaison Japan
Cc: LIA01 Hoc; LIA03 Hoc
Subject: FW: UPDATE and INPUT: Japanese Government Action Items and Material Request List (Consortium Call) Rev 1 03 29 (2).xlsx
Attachments: Japanese Government Action Items and Material Request List (Consortium Call) Rev 1 03 29 (2).xlsx

From: LIA01 Hoc
Sent: Thursday, March 31, 2011 2:51 PM
To: LIA02 Hoc
Subject: FW: UPDATE and INPUT: Japanese Government Action Items and Material Request List (Consortium Call) Rev 1 03 29 (2).xlsx

Lauren,

Please forward to the NRC Japan team.

Thanks.

Jason
Federal Liaison

From: Nielsen, Rick M (INPO) [mailto: (b)(6)]
Sent: Thursday, March 31, 2011 1:35 PM
To: LIA01 Hoc
Cc: Nielsen, Rick M (INPO); Addy, Robert J (INPO); Tropasso, Randy T. (INPO); Bramblett, Jeff W.; Maddox, James E. (INPO); Manaskie, George E. (INPO)
Subject: UPDATE and INPUT: Japanese Government Action Items and Material Request List (Consortium Call) Rev 1 03 29 (2).xlsx

(b)(4),(b)(5)

Thank you very much,

Rick Nielsen

INPO
770-644-8118
(b)(6)

DRAFT Japanese Government Action Items and Material Request List

Updates Are Forwarded To Conference Call Attendees At the Following Times Each Day (EDT):

0700 hrs; 1500 hrs; 1900 hrs; 2300 hrs

Item#	Action Item Description	Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
1	(b)(5)	INPO	(b)(5)	Open	(b)(5)	
2		INPO		Closed		
3		INPO		Closed		
		INPO		Open Closed		
4		INPO		Open		

)ocument is current as of:
:14 AM
/20/2011

DRAFT Japanese Government Action Items and Material Request List

Updates Are Forwarded To Conference Call Attendees At the Following Times Each Day (EDT): 0700 hrs; 1500 hrs; 1900 hrs; 2300 hrs

Item#	Action Item Description	Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
5		INPO		Open Closed		
6		INPO		Open Closed		
7		INPO		Open Closed		
8		INPO		Open Closed		
9	(b)(5)	INPO	(b)(5)	Open Closed		(b)(5)
10		INPO		Open		
11		INPO		Closed		

Document is current as of:
7:14 AM
4/20/2011

DRAFT Japanese Government Action Items and Material Request List

Updates Are Forwarded To Conference Call Attendees At the Following Times Each Day (EDT): 0700 hrs; 1500 hrs; 1900 hrs; 2300 hrs

Item#	Action Item Description	Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
12	(b)(5)	INPO	(b)(5)	Open Closed		(b)(5)
13		INPO		Open		
14		INPO		Open		

DRAFT Japanese Government Action Items and Material Request List
Updates Are Forwarded To Conference Call Attendees At the Following Times Each Day (EDT): 0700 hrs; 1500 hrs; 1900 hrs; 2300 hrs

Item#	Action Item Description	Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
12	(b)(5)	(b)(5)		Open		
13	(b)(5)		(b)(5)			

Document is current as of:
7:14 AM
4/20/2011

DRAFT Japanese Government Action Items and Material Request List
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0700 hrs; 1500 hrs; 1900 hrs; 2300 hrs

Item#	Action Item Description	Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
14	(b)(5)		(b)(5)	Open	(b)(5)	
15				Open		
16				Open		
17				Open		
18				Open		

DRAFT Japanese Government Action Items and Material Request List
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0700 hrs; 1500 hrs; 1900 hrs; 2300 hrs

Item#	Action Item Description	Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
19	(b)(5)			Open	(b)(5)	
20			See above	Open		
21				Open		
22			(b)(5)	Open		

Document is current as of:
7:14 AM
4/20/2011

****DRAFT** Japanese Government Action Items and Material Request List**
Updates Are Forwarded To Conference Call Attendees At the Following Times Each Day (EDT):
0700 hrs; 1500 hrs; 1900 hrs; 2300 hrs

Item#	Action Item Description	Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
23	(b)(5)	(b)(5)	(b)(5)	Open		
24				Open		
25				Open		
26				Open		
27				Open		
28				Open		
29				Closed 3/29	(b)(5)	

DRAFT Japanese Government Action Items and Material Request List
Updates Are Forwarded To Conference Call Attendees At the Following Times Each Day (EDT):
0700 hrs; 1500 hrs; 1900 hrs; 2300 hrs

Item#	Action Item Description	Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
30	(b)(5)	(b)(5)		Open	(b)(5)	
31				Open		
32				Open		
33				Open		
34				Open		
35						
36						

Document is current as of:
7:14 AM
4/20/2011

From: Hoc, PMT12
Sent: Friday, April 01, 2011 7:57 AM
To: Blount, Tom
Cc: ET07 Hoc
Subject: Commission/ Chairmen Update
Attachments: Major dose assessment matrix_03312011.xlsx; 2011 04-01 Re-entry criteria Task 3108 (2) (3).doc

- **U.S. Citizens in Japan: Thresholds and Planning**

(b)(5)

- **Stakes and Management of the United States-Japan Alliance (DOS)/ Resource Management and Coordination**

(b)(5)

- **Domestic Preparedness**

(b)(5)

(b)(5)

- **Discussion**
  - (b)(5)

From:	ET07 Hoc
Sent:	Friday, April 01, 2011 8:56 AM
To:	LIA07 Hoc
Subject:	FW: HEADS UP - USNRC REACTOR SAFETY TEAM ASSESSMENT REV 1
Attachments:	03-31-11 1200 RST Assessment Document REV 1 .docx; RST ASSESSMENT CONCURRENCE OFFICIALS 3-31-2011.docx

Please ensure that this version of the document gets onto the designated sharepoint site. Thanks.

From: Weber, Michael
Sent: Friday, April 01, 2011 8:55 AM
To: PMT01 Hoc; Hoc, PMT12; LIA06 Hoc; LIA08 Hoc; ET07 Hoc; ET05 Hoc; OST02 HOC
Cc: FOIA Response.hoc Resource; Leeds, Eric; Johnson, Michael; Sheron, Brian; Haney, Catherine; Boger, Bruce; Carpenter, Cynthia; RST01 Hoc
Subject: HEADS UP - USNRC REACTOR SAFETY TEAM ASSESSMENT REV 1

To ensure a coordinated response, if you are referring to the severe accident mitigation strategies document that was developed and coordinated by the RST, please use the attached versions as the official version of Revision 1 of the document.

Thanks

From: RST01 Hoc
Sent: Friday, April 01, 2011 8:33 AM
To: Blount, Tom; ET07 Hoc; Weber, Michael
Subject: FW: USNRC REACTOR SAFETY TEAM ASSESSMENT REV 1

See attached RST assessment and list of approving officials.

Thank you

Brett Rini
RST Coordinator

From: RST01 Hoc
Sent: Thursday, March 31, 2011 7:10 PM

(b)(6)

Cc: RST01 Hoc; RST02 Hoc; RST07 Hoc; RST09 Hoc; Hoc, RST16; ET07 Hoc; ET02 Hoc; ET05 Hoc
Subject: FW: USNRC REACTOR SAFETY TEAM ASSESSMENT REV 1

All addressees:

Attached please find REV 1 to the RST Assessment Document, along with a separate table indicating the senior officials who represented the key agencies/organizations with whom we have consulted to produce the assessment report.

John Thorp
Reactor Safety Team Communicator

From: 佐藤 隆
To: Taylor, Robert
Subject: Radiation Dose Map
Date: Friday, April 01, 2011 10:02:56 AM
Attachments: 20110401_1FSurveyMap.ppt

Dear Mr. Taylor

Attached contains the revised dose map of Fukushima Daiichi site.

I appreciate your support.

Best regards,

Takashi Sato
TEPCO

東京電力株式会社
本店　子力·立　業務
　子力企画グループマネージャー
佐藤 隆(Takashi Sato)
〒100-8560 東京都千代田区内幸町1-1-3
TEL:03-6373-4721
FAX:03-3596-8538
E-Mail:satoh.takashi@tepco.co.jp

(b)(4)

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Depta, George (GE Power & Water)

From:	GE Hitachi Nuclear Response Team (GE Power & Water)
Sent:	Friday, April 01, 2011 6:43 AM
To:	ENERGY GEH ICC Engineering (GE Power & Water); Klapproth, James F (GE Power & Water)
Subject:	Q372 NRC Mark I Containment issues data & timeline up to GL 89-16

(b)(4)

George

From: Stoddard, Thomas C (GE Power & Water)
Sent: Thursday, March 31, 2011 4:46 PM
To: Harrison, James F. (GE Power & Water)
Cc: GE Hitachi Nuclear Response Team (GE Power & Water)
Subject: RE: GE SILs Related to BWR Mark 1 Containment Improvements

Jim,

(b)(4)

Tom

From: Harrison, James F. (GE Power & Water)
Sent: Thursday, March 31, 2011 8:17 AM
To: Stoddard, Thomas C (GE Power & Water)
Subject: FW: GE SILs Related to BWR Mark 1 Containment Improvements

(b)(4)

Thanks, Jim H

From: Philpott, Stephen [mailto:Stephen.Philpott@nrc.gov]
Sent: Wednesday, March 30, 2011 5:24 PM
To: Harrison, James F. (GE Power & Water)
Subject: GE SILs Related to BWR Mark 1 Containment Improvements

Jim,

We have a reviewer in the Operating Experience branch who is working to develop a timeline/history of the Mark I containment improvement program starting from when the BWR owner's group was formed to address concerns with hydrodynamic loading in the torus (late 70s early 80s) all the way through the GL 89-16 recommendation for hardened vents. Would you be able to provide copies of any GE SILs or other documents that GE put out describing recommendations for improvements to the Mark I design?

I don't know how extensive a list of such documents (or the search to find them) would be. The staff mentioned the hydrodynamic loading and the hardened vents topics in particular. Let me know if there are other preferred channels or ways to go about this. We can discuss it more tomorrow and I can give you a little more background and plans for this.

Thank you,
Steve

Steve Philpott
Licensing Processes Branch (PLPB)
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
phone: 301-415-2365
e-mail: Stephen.Philpott@nrc.gov

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

From: Aviles, Armando LT USN
To: Taylor, Robert
Subject: RE: BWR Radiation Fields
Date: Friday, April 01, 2011 6:05:05 PM

Mr. Taylor,

Thank you for the information, this is most beneficial to us.

Best Regards,

LT Armando Aviles
USFJ CAT RCMT
(b)(6)

-----Original Message-----
From: Taylor, Robert [mailto:Robert.Taylor@nrc.gov]
Sent: Saturday, April 02, 2011 6:51 AM
To: Aviles, Armando LT USN
Cc: Scott, Michael
Subject: FW: BWR Radiation Fields

Lieutenant,

Sorry for the delay in getting back to you. I believe the information answers your questions.

Regards,

Rob Taylor

USNRC

From: RST01 Hoc
Sent: Friday, April 01, 2011 1:44 PM
To: Taylor, Robert; Scott, Michael
Subject: FW: BWR Radiation Fields

In response to your request regarding typical radiation readings, see below.

From: Keithley, James A. (INPO)
Sent: Friday, April 01, 2011 1:08 PM
To: Ruppert, Gregory F. (INPO)
Cc: INPOERCTech; INPOERCRP

Subject: BWR Radiation Fields

(b)(4)

Jim Keithley

Sr. Evaluator

Radiological Protection

Institute of Nuclear Power Operations

(b)(6)

(770) 644-8741

From: RST01 Hoc
Sent: Friday, April 01, 2011 7:37 AM
To: Blount, Tom; ET07 Hoc
Subject: FW: RST Assessment of Fukushima Daiichi Units (Rev 1)
Attachments: 03-31-11 1200 RST Assessment Document REV 1 .docx

Tom,

As requested, please find attached the latest RST Assessment document. Please also append the additional information provided by Naval Reactors in the e-mail below.

Brett
RST Coordinator

From: RST01 Hoc
Sent: Thursday, March 31, 2011 1:26 PM
To: Giessner, John; Scott, Michael; Taylor, Robert; Casto, Chuck; ET07 Hoc; Boger, Bruce

(b)(6)

Subject: FW: RST Assessment of Fukushima Daiichi Units (Rev 1)

Site Team,

This has been vetted by the technical members of the Industry Consortium (cc'd on this email) and has been agreed upon by most of their senior supervision.
It is therefore being forwarded to you at the behest of the ET Director.

RST Coordinator

From: RST08 Hoc
Sent: Thursday, March 31, 2011 1:02 PM
To: RST01 Hoc; RST03 Hoc
Subject: RST Assessment of Fukushima Daiichi Units (Rev 1)

Attached is the RST Assessment of Fukushima Daiichi Units (Rev 1) with a forwarding memo requested by Naval Reactors.

Revision 1 to the RST assessment is attached. This revision accomplishes two principal objectives:

(b)(5)

(b)(5)

Let me know if you have any questions

Mike

Mike Brown
Reactor Safety Team

RST Assessment of Fukushima Daiichi Units (REV 1), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

1200 hrs 3/31/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

General Discussion of Desired End State

(b)(4),(b)(5)

1200 hrs 3/31/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.
The <u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.
The <u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Majority of core is probably contained in the reactor pressure vessel (RPV); TEPCO believes the reactor water level may be 63 inches below TAF. The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

Vessel temperatures and pressures:

131.2°C at bottom drain and 277.8 °C at FW nozzle (TEPCO 0700 JDT 3/30) (both decreasing trend) (TEPCO 0700 JDT 3/30). RPV at 70.2 psia (increasing trend), DW and torus pressure at 35 psia (decreasing trend) (TEPCO 0700 JDT 3/30).

Core Cooling: Currently fresh water injection with no boron, injecting through feedwater line at 133 l/min. Injection is from a temporary motor driven pump powered from a temporary diesel generator (TEPCO); Injection flow rate will be maintained above the minimum debris retention injection rate (MDRIR). Recirculation pump seals have likely failed. (GEH); Injection flow rate above MDRIR could not be maintained through core spray. Assume shutdown cooling system is not available.

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Not damaged, 35 psia. Drywell and Torus hydrogen and oxygen concentrations are unknown. (b)(4),(b)(5) The status of the nitrogen purge capability is unknown. (b)(4),(b)(5) An explosive mixture is possible.

Secondary Containment:

Severely damaged (hydrogen explosion).

Spent Fuel Pool:

The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)

Rad levels: DW 3710 R/hr, Torus 1900 R/hr (CAMS), Outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(5) (b)(5) entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5)

  (b)(4),(b)(5)

- Vent containment (b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c.
  d.

  (b)(4),(b)(5)

-
-

  (b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

Additional Considerations

A. The following considerations apply to containment venting:

1. (b)(4),(b)(5)
2.
3.
4. Spray water on steam plumes and planned containment vents for scrubbing effect and (b)(4),(b)(5)
5.

B. Additional Miscellaneous considerations

1. (b)(4),(b)(5)
2. Borate water if possible.
3. Ensure spent fuel pool level is maintained as full as possible.
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5)
5.

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b)(suction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)

4\.
5\.
(b)(4),(b)(5)

UNIT TWO

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Majority of core is probably contained in the reactor vessel. Reactor water level may be 59 inches below TAF (TEPCO). (b)(4),(b)(5)

Core Cooling: Freshwater injection via injection of non-borated fresh water using the low pressure coolant injection (LPCI) continues. Injection is from a temporary motor driven pump powered from a temporary diesel generator (3/29/11 TEPCO), Flow rate 117 l/min. Bottom head temperature 131.6 C, feed water nozzle temperature 172.4 C (TECPO 0700 3/30/11)) Recirculation pump seals have likely failed. (Industry)

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

Drywell pressure reading 14.5 psia (3/30/11 TEPCO)

Secondary Containment:

Damaged (JAIF, NISA, TEPCO), steam or vapor can be seen coming from the blowout panel in the reactor building (b)(5) 3/27/11).

Spent Fuel Pool:

Freshwater being injected directly into the spent fuel pool as of 3/29/11 (TEPCO) using a pump supplied from off-site power. The Unit 2 spent fuel pool is as 46 degrees centigrade or 115 degrees Fahrenheit. (b)(4),(b)(5) (b)(4),(b)(5)

Rad Levels: Drywell 3999 R/hr; Torus 128 R/hr (CAMS);

Outside plant: 11 mR/hr at gate (variable) (TEPCO 0700 JDT 3/30)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. Technicians are continuing to check DC distribution panels.

ASSESSMENT:

Damaged fuel may have slumped with the majority located on the core plate and fuel in the lower region of the core is likely encased in salt. However, the amount of salt build-up appears to be less than U-1 based on the reported lower temperatures. (b)(4),(b)(5) Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling flow is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

The primary containment is damaged

RST Assessment of Fukushima Daiichi Units (REV 1),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

1200 hrs 3/31/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT 2

RECOMMENDATIONS: (for consideration to stabilize Unit 2)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)

-

- (b)(4),(b)(5)

-

- Vent containment: (see Additional Considerations A.1. through A.5. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)

d. (b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.4 below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.
5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5):

a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
b. Radiation monitoring instruments (b)(4),(b)(5)
c.
d. (b)(4),(b)(5)
e.

UNIT THREE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Majority of core is probably contained in reactor vessel; (b)(4),(b)(5) (b)(4),(b)(5) TEPCO believes the reactor water level is 79 inches below TAF. (b)(4),(b)(5) (b)(4),(b)(5)

Core Cooling: Freshwater injection via injection of non-borated fresh water injection using the low pressure coolant injection (LPCI) continues. Injection is from a temporary motor driven pump powered from a temporary diesel generator (3/29/11 TEPCO), Bottom head temperature 116 C, feed water nozzle temperature Unreliable (0800 3/30/11 TEPCO) Recirculation pump seals have likely failed.

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)

Drywell pressure 15.53 psia, Torus pressure 25.82 psia (0800 3/30/11 TEPCO)

Secondary Containment

Damaged (JAIF, NISA, TEPCO)

Spent Fuel Pool

Unknown temperature and water level (TEPCO) freshwater is being sprayed as needed using a cement truck.

Rad Levels: DW 2760 R/hr, torus 111 R/hr (3/30/11 TEPCO);

Outside plant: 11 mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: External AC power has reached the unit, checking integrity of equipment before energizing. In Unit 3, lighting distribution panels are being checked.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Water injection is to the RPV through the RHR system via the recirculation piping, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement has flooded. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

1200 hrs 3/31/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT 3

RECOMMENDATIONS: (for consideration to stabilize Unit 3)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)
-
-
- (b)(4),(b)(5)
- Vent containment: (see Additional Considerations A.1. through A.8. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.

c.
d.
(b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
(b)(4),(b)(5)
3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5):
   a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
   b. Radiation monitoring instruments (b)(4),(b)(5)
   c.
   d.
   (b)(5)

UNIT FOUR

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)

Core Cooling: Not necessary (JAIF, NISA, TEPCO)

Primary Containment:
Not applicable (JAIF, NISA, TEPCO)

Secondary Containment:
Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature is unknown (NISA).

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

1. Maintain coverage of spent fuel pool with fresh borated water.
2. As possible, put spent fuel cooling and cleanup in service.

UNIT FIVE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: In vessel (JAIF, NISA, TEPCO)

Core Cooling: Functional (JAIF, NISA, TEPCO)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Fuel pool cooling functioning Temperature 37.9 C (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

1200 hrs 3/31/2011

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UNIT SIX

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: In vessel (JAIF, NISA, TEPCO)

Core Cooling: Functional (JAIF, NISA, TEPCO)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

~~Official Use Only~~

Key Agency/Organization Input to RST Assessment of Fukushima Dai-ichi (REV 1) Document

Table of Senior/Approving Officials

AGENCY/ ORGANIZATION	CONCURRENCE STATEMENT	SENIOR REVIEWING OFFICIAL	TITLE	AS REPORTED BY
Naval Reactors, KAPL & BETTIS				
GE Hitachi				
INPO				
DOE/NE		(b)(4),(b)(5),(b)(6)		
EPRI				

From: RST01 Hoc
Sent: Saturday, April 02, 2011 11:25 AM
To: (b)(6)
Subject: FW: RST Spent Fuel Pool Assessment
Attachments: Q377 RST Assessment Spent Fool Pool Document REV 0 GEH Markup.docx

From: GE Hitachi Nuclear Response Team (GE Power & Water) [mailto (b)(6)]
Sent: Saturday, April 02, 2011 8:04 AM
To: RST01 Hoc
Subject: RE: RST Spent Fuel Pool Assessment

(b)(4)

GEH ICC

From: RST01 Hoc [mailto:RST01.Hoc@nrc.gov]
Sent: Friday, April 01, 2011 7:10 AM
To: GE Hitachi Nuclear Response Team (GE Power & Water); INPO EmergencyResponseCtr (INPO); Modeen, David; RST03 Hoc; Casto, Chuck; Taylor, Robert; Scott, Michael
Subject: FW: RST Spent Fuel Pool Assessment

From: RST07 Hoc
Sent: Friday, April 01, 2011 6:58 AM
To: RST01 Hoc
Cc: RST07 Hoc; RST08 Hoc; RST06 Hoc
Subject: RST Spent Fuel Pool Assessment

Attached please see the initial draft of the Spent Fuel Pool Assessment Document. Please provide your comments to the RST team.

~~Official Use Only~~

RST Assessment of Fukushima Daiichi Units (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2400 hrs 4/01/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2400 hrs 4/01/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

(b)(4),(b)(5)

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UNIT ONE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

SFP Status: 292 bundles (b)(4),(b)(5)
(b)(4),(b)(5)
4/1) 131.2°C at bottom drain and 277.8 °C at FW nozzle (TEPCO 0700 JDT 3/30)

RST Assessment of Fukushima Daiichi Units (REV 0), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2400 hrs 4/01/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

(b)(4),(b)(5)

Rad levels: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

Reactor water is in the Turbine Building basement (NISA).

(b)(4),(b)(5)

ASSESSMENT:

(b)(4),(b)(5)

RECOMMENDATIONS: (b)(4),(b)(5)

(b)(4),(b)(5)

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-

Additional Considerations

A. (b)(4),(b)(5)

~~A.~~

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RST Assessment of Fukushima Daiichi Units (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2400 hrs 4/01/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT TWO

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

SFP Status: 587 bundles (b)(4),(b)(5) 3/30)

(b)(4),(b)(5)

Rad Levels: Drywell 3999 R/hr; Torus 128 R/hr (CAMS);

Outside plant: 11 mR/hr at gate (variable) (TEPCO 0700 JDT 3/30)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. Technicians are continuing to check DC distribution panels.

ASSESSMENT:

(b)(4),(b)(5)

RECOMMENDATIONS: (b)(4),(b)(5)

(b)(4),(b)(5)

- (b)(4),(b)(5)
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-

Additional Considerations

RST Assessment of Fukushima Daiichi Units (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2400 hrs 4/01/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

(b)(4),(b)(5)

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UNIT THREE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

SFP Status: 514 bundles (b)(4),(b)(5)

Rad Levels: DW 2760 R/hr, torus 111 R/hr (3/30/11 TEPCO);

Outside plant: 11 mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: External AC power has reached the unit, checking integrity of equipment before energizing. In Unit 3, lighting distribution panels are being checked.

ASSESSMENT:

(b)(4),(b)(5)

RECOMMENDATIONS: (b)(4),(b)(5)
(b)(4),(b)(5)

- (b)(4),(b)(5)
-

RST Assessment of Fukushima Daiichi Units (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2400 hrs 4/01/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

- (b)(4),(b)(5)

Additional Considerations

A. (b)(4),(b)(5)

B.

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UNIT FOUR

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

SFP Status: 1331 bundles in SFP (b)(4),(b)(5)

Low water level, spraying with sea water, hydrogen from the fuel pool exploded (b)(4),(b)(5) fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature is unknown (NISA).

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2400 hrs 4/01/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

RECOMMENDATIONS: (b)(4),(b)(5)

(b)(4),(b)(5)

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- ➢ (b)(4),(b)(5)
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Additional Considerations

A. (b)(4),(b)(5)

~~G.~~

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UNIT FIVE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Spent Fuel Pool:

Fuel pool cooling functioning Temperature 37.9 °C~~C~~ (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling. (b)(4),(b)(5)

Monitor

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT SIX

ASSUMPTIONS: (based on input from multiple data source: (JAIF, NISA, TEPCO, & GEH)

Spent Fuel Pool:
Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

From: Wiggins, Jim
To: Hayden, Elizabeth; Weber, Michael; Burnell, Scott
Cc: Bergman, Thomas; LIA01 Hoc
Subject: RE: RESPONSE - RST ASSESSMENT (Rev. 1) [OUO attachment]
Date: Wednesday, April 06, 2011 11:08:37 AM

LIA01, currently Tom Bergman, is responsible for getting and distributing, internally, the initial (3/26) RST Assessment and Rev 1 (3/31).

From: Hayden, Elizabeth
Sent: Wednesday, April 06, 2011 11:03 AM
To: Weber, Michael; Burnell, Scott
Cc: Wiggins, Jim
Subject: RE: RESPONSE - RST ASSESSMENT (Rev. 1) [OUO attachment]

I understand OIG is looking for the 3/26 report as well.

Beth Hayden
Senior Advisor
Office of Public Affairs
U.S. Nuclear Regulatory Commission
--- Protecting People and the Environment
301-415-8202
elizabeth.hayden@nrc.gov

From: Weber, Michael
Sent: Wednesday, April 06, 2011 10:52 AM
To: Burnell, Scott
Cc: Hayden, Elizabeth; Wiggins, Jim
Subject: RESPONSE - RST ASSESSMENT (Rev. 1) [OUO attachment]

You'll want to refer to the Revision 1 with a 3/31/2011 date (v. 3/30). It is attached. Note that it is also OUO.

From: Burnell, Scott
Sent: Wednesday, April 06, 2011 10:36 AM
To: Weber, Michael; Hayden, Elizabeth; Wiggins, Jim
Cc: Rothschild, Trip; Ash, Darren; Boyce, Thomas (OIS); Powell, Amy; Schmidt, Rebecca; ET05 Hoc; ET01 Hoc; OST02 HOC; Batkin, Joshua; Coggins, Angela
Subject: RE: RESPONSE - Phone Message - Beth Hayden x8202

I have a copy of the 3/26 assessment from the RST. I've asked for a copy of the 3/30 version for internal use only.

From: Weber, Michael
Sent: Wednesday, April 06, 2011 10:35 AM
To: Hayden, Elizabeth; Wiggins, Jim
Cc: Rothschild, Trip; Ash, Darren; Boyce, Thomas (OIS); Powell, Amy; Schmidt, Rebecca; Burnell, Scott; ET05 Hoc; ET01 Hoc; OST02 HOC; Batkin, Joshua; Coggins, Angela
Subject: RESPONSE - Phone Message - Beth Hayden x8202

Do you have the document (March 26 RST Assessment) or do you need the Ops Center to forward it to you?

(b)(5)

From: Hayden, Elizabeth
Sent: Wednesday, April 06, 2011 9:16 AM
To: Weber, Michael
Subject: FW: Phone Message - Beth Hayden x8202

(b)(5)

Beth Hayden
Senior Advisor
Office of Public Affairs
U.S. Nuclear Regulatory Commission
--- Protecting People and the Environment
301-415-8202
elizabeth.hayden@nrc.gov

From: Boyer, Rachel
Sent: Wednesday, April 06, 2011 9:12 AM
To: Hayden, Elizabeth
Subject: RE: Phone Message - Beth Hayden x8202

Sorry Beth,

I was looking at your name and trying to send the message to Mike. I have re-sent it to Mike's attention. Thanks!

Rachel

From: Boyer, Rachel
Sent: Wednesday, April 06, 2011 9:11 AM
To: Hayden, Elizabeth
Subject: Phone Message - Beth Hayden x8202
Importance: High

Please give her a call as soon as you have time. She did not leave a description of the subject. Thanks!

Rachel

Rachel C. Boyer
Administrative Assistant for Michael Weber
Office of the Executive Director for Operations
U.S. Nuclear Regulatory Commission
☎ Office: (301) 415-1707
Fax: (301) 415-2162
Mail Stop: O16-E15
E-mail: Rachel.Boyer@nrc.gov

From:	Powell, Amy
Sent:	Thursday, April 07, 2011 2:58 PM
To:	Batkin, Joshua
Subject:	FW: RST Assessemnts
Attachments:	03-26-2100 Final RST assessment of Daiichi Units document.docx; 03-31-11 1200 RST Assessment Document REV 1 .docx

From: LIA06 Hoc
Sent: Wednesday, April 06, 2011 12:37 PM
To: Powell, Amy; Schmidt, Rebecca; Burnell, Scott
Cc: LIA08 Hoc
Subject: FW: RST Assessemnts

Attached are the 3/26 (Rev 0) version of the RST assessment, which we believe the NY Times article refers to, and the 3/31 Rev 1 version.

As a heads up these documents were developed over a period of time so there are other versions, with different time stamps. It is possible the NYT got a different version. However, these were the final versions of each Revision.

We are arranging a meeting tomorrow in the ET room to decide whether and when to release this document. OCA and OPA will be invited.

Tom Bergman
Liaison Team Director
U.S. Nuclear Regulatory Commission
Operations Center

From: RST01 Hoc
Sent: Wednesday, April 06, 2011 12:13 PM
To: LIA06 Hoc
Cc: RST06 Hoc; RST01B Hoc
Subject: RE: RST Assessemnts

As Requested
RST Coordinator

From: LIA06 Hoc
Sent: Wednesday, April 06, 2011 11:14 AM
To: RST01 Hoc
Cc: RST06 Hoc; RST01B Hoc
Subject: RE: RST Assessemnts

This does not match the hard copy version that has been shared within the Ops Center. The version we believe has been widely shared is dated 2100 hrs 3/26/2011, and was the version referred to by Pat Castleman during the 10 am call this morning. The version attached to your email is dated 0600 3/26/2001.

Similarly, the Rev 1 version is dated 1200 hrs 3/31, and is an actual revision to the document. The Rev 1 we have in hardcopy is more of an amendment, one page, and with no date stamp.

As we have been asked to provide these to OCA to provide to Congressional staff, and potentially to others, we need to make sure we are all working from the same versions. Please verify the versions of Rev 0 (believe 2100 is correct, and need a copy if so) and Rev 1 you sent are the correct versions.

Thanks

Tom Bergman
Liaison Team Director
U.S. Nuclear Regulatory Commission
Operations Center

From: RST01 Hoc
Sent: Wednesday, April 06, 2011 10:55 AM
To: LIA06 Hoc
Cc: RST06 Hoc; RST01B Hoc
Subject: RST Assessemnts

The redline assessment from May 26 th
and
the May 31 Rev 1 of the assessment
are attached.

RST Coordinator

~~Official Use Only~~

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2100 hrs 3/26/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT ONE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Core is contained in the reactor pressure vessel, reactor water level is unknown. The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

Vessel temperatures and pressures:
149°C at bottom drain and 197°C at FW nozzle (NISA 1800 JDT 3/25)
RPV at 65.7 psia (increasing trend), DW and torus pressure at 40 psia (decreasing trend) (NISA 1800 JDT 3/25).

Core Cooling: Currently fresh water injection with no boron, injecting through feedwater 120 l/min or 31.7 g/m (NISA); Injection flow rate will be maintained above the minimum debris retention injection rate (MDRJR). Recirculation pump seals have likely failed. (GEH) Injection flow rate above MDRIR could not be maintained through core spray. Assume RHR is not available.

Primary Containment:
Not damaged, 40 psia Drywell and Torus hydrogen and oxygen concentrations are unknown. The status of the nitrogen purge capability is unknown. An explosive mixture is possible.

Secondary Containment:
Severely damaged (hydrogen explosion).

Spent Fuel Pool:
Fuel covered, no seawater injected - (JAIF, NISA, TEPCO). The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)

Rad levels: DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown),
Outside plant: 26mR/hr at gate (variable) (INPO 0900 hrs 3/25/11)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO)
External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1.

Reactor water is in the Turbine Building basement (NISA).

NOTE: Recommendations are based on validity of above assumptions.

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2100 hrs 3/26/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GE believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

Follow guidelines of SAMG-1, *Primary Containment Flooding*, Leg RC/F-4, *Can you restore and hold RPV injection rate above the Minimum Debris Retention Injection Rate (MDRIR)*?

1. Inject into the RPV with all available resources while maintaining total RPV injection flow at the current flow rate (must maintain greater than MDRIR). Systems to use are:
    a. core spray, even at reduced flow rate
    b. feedwater system
    c. other systems as they become available

2. Restore nitrogen purge capability. When restored, establish purge and vent cycle to minimize explosive potential.

3. RPV injection can be maximized when the containment has been purged with nitrogen and vented.

4. No overt action is necessary to inject into the primary containment. The primary containment injection flow path is through the RPV.

5. Vent containment: (see Additional Considerations A.1. through A.8. below)
    a. To maintain containment pressure below the primary containment pressure limit.
    b. As necessary to maintain RPV injection above MDRIR.

6. Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below).

Additional Considerations

A. The following considerations apply to containment venting:

   1. If the primary containment is vented then purge the drywell with nitrogen at maximum flow.

   2. If the torus is vented then purge the torus with nitrogen at maximum flow.

   3. Attempt to inert with nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert.

   4. Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing hydrogen detonation

   5. Hydrogen gas production is more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. Maintain venting capability.

   6. Containment spray should be secured before 2 psig to prevent opening vacuum breakers.

   7. Spray water on steam plumes and planned containment vents for scrubbing effect.

   8. Avoid atmospheric thermal inversion (in the afternoon) when venting to minimize dose.

B. Additional Miscellaneous considerations

   1. When flooding containment, consider the implications of water weight on seismic capability of containment.

   2. Borate water if possible. (With salt in vessel, consider effect of acidic conditions in vessel when deciding how much boron to add.)

3. Ensure spent fuel pool level is maintained as full as possible.

4. CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

C. Potential methods for monitoring containment level:
1. HPCI suction pressure
2. Drywell instrument taps
3. Radiation monitoring instruments

UNIT TWO

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Core is contained in the reactor pressure vessel, reactor water level is unknown.

Core Cooling: Fresh water with boric acid injection (TEPCO), bottom head temperature 104C, feed water nozzle temperature 107C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (Industry)

Primary Containment:
Damage suspected (JAIF, NISA, TEPCO)

Secondary Containment:
Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual).

Spent Fuel Pool:
Fuel covered, seawater injected on March 20, fuel pool temperature 52°C (JAIF, NISA, TEPCO 1800 JDT 3/25/11).

Rad Levels: Drywell 4560 R/hr; Torus 154 R/hr (source instruments unknown); Outside plant: 26mR/hr at gate (variable) (Industry).

Other: External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the RHR system is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RPV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage.

It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

NOTE: Recommendations are based on validity of above assumptions.

RECOMMENDATIONS: (for consideration to stabilize Unit 2)

Follow guidelines of SAMG-1, *Primary Containment Flooding*, Leg RC/F-4, *Can you restore and hold RPV injection rate above the Minimum Debris Retention Injection Rate (MDRIR)*?

1. Inject into the RPV with all available resources while maintaining total RPV injection flow at the current flow rate (must maintain greater than MDRIR). Systems to use are:
    a. core spray, even at reduced flow rate
    b. feedwater system
    c. other systems as they become available

2. Restore nitrogen purge capability. When restored, establish purge and vent cycle to minimize explosive potential.

3. RPV injection can be maximized when the containment has been purged with nitrogen and vented.

4. No overt action is necessary to inject into the primary containment. The primary containment injection flow path is through the RPV.

5. Vent containment: (see Additional Considerations A.1. through A.8. below)
    a. To maintain containment pressure below the pressure limit
    b. As necessary to maintain RPV injection above MDRIR

6. Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below)

Additional Considerations

A. The following considerations apply to containment venting:

1. If the primary containment is vented then purge the drywell with nitrogen at maximum flow.

2. If the Torus is vented then purge the torus with nitrogen at maximum flow.

3. Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert.

4. Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation.

5. Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. Maintain venting capability.

6. Containment spray should be secured before 2 psig to prevent opening vacuum breakers.

7. Spray water on steam plumes and planned containment vents for scrubbing effect.

8. Avoid atmospheric thermal inversion (in the afternoon) when venting to minimize dose.

B. Additional Miscellaneous considerations

1. When flooding containment, consider the implications of water weight on seismic capability of containment.

2. Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)

3. Ensure Spent Fuel Pool level is maintained as full as possible.

4. CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

C. Potential methods for monitoring containment level:
1. HPCI suction pressure
2. Drywell instrument taps
3. Radiation monitoring instruments

2100 hrs 3/26/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT THREE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Core is contained in reactor vessel, reactor water level is unknown.

Core Cooling: Freshwater injection via fire line initiated 1802 JDT 3/25/11 (NISA), bottom head temperature 111C, feed water nozzle temperature Unreliable (JAIF, NISA 1800 JDT 3/25/11, TEPCO) Recirculation pump seals have likely failed.

Primary Containment
Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)

Secondary Containment
Damaged (JAIF, NISA, TEPCO)

Spent Fuel Pool
Low water level (JAIF, NISA, TEPCO), spraying and pumping sea water into the SFP via the Cooling and Purification Line (NISA)

Rad Levels: DW 5100 R/hr, torus 150 R/hr (Industry);
Outside plant: 26mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the RHR system is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RPV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage.

It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement has flooded. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS: (for consideration to stabilize Unit 3)

Follow guidelines of SAMG-1, *Primary Containment Flooding*, Leg RC/F-4, *Can you restore and hold RPV injection rate above the Minimum Debris Retention Injection Rate (MDRIR)?*

1. Inject into the RPV with all available resources while maintaining total RPV injection flow at the current flow rate (must maintain greater than MDRIR). Systems to use are:
    a. core spray, even at reduced flow rate.
    b. feedwater system.
    c. other systems as they become available.

2. Restore nitrogen purge capability. When restored, establish purge and vent cycle to minimize explosive potential.

3. RPV injection can be maximized when the containment has been purged with nitrogen and vented.

4. No overt action is necessary to inject into the primary containment. The primary containment injection flow path is through the RPV.

5. Vent containment: (see Additional Considerations A.1. through A.8. below)
    a. To maintain containment pressure below the pressure limit.
    b. As necessary to maintain RPV injection above MDRIR.

6. Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below)

Additional Considerations

A. The following considerations apply to containment venting:

1. If the primary containment is vented then purge the drywell with nitrogen at maximum flow.

2. If the torus is vented then purge the torus with nitrogen at maximum flow.

3. Attempt to inert with nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert.

4. Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing hydrogen detonation.

5. Hydrogen gas production is more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. Maintain venting capability.

6. Containment spray should be secured before 2 psig to prevent opening vacuum breakers.

7. Spray water on steam plumes and planned containment vents for scrubbing effect.

8. Avoid atmospheric thermal inversion (in the afternoon) when venting to minimize dose.

B. Additional Miscellaneous considerations

1. When flooding containment, consider the implications of water weight on seismic capability of containment.

2. Borate water if possible. (With salt in vessel, consider effect of acidic conditions in vessel when deciding how much boron to add.)

3. Ensure Spent Fuel Pool level is maintained as full as possible.

4. CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

C. Potential methods for monitoring containment level:
1. HPCI suction pressure
2. Drywell instrument taps
3. Radiation monitoring instruments

2100 hrs 3/26/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT FOUR

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)

Core Cooling: Not necessary (JAIF, NISA, TEPCO)

Primary Containment:
Not applicable (JAIF, NISA, TEPCO)

Secondary Containment:
Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature is unknown (NISA).

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

1. Maintain coverage of spent fuel pool with fresh borated water.
2. As possible, put spent fuel cooling and cleanup in service.

UNIT FIVE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: In vessel (JAIF, NISA, TEPCO)

Core Cooling: Functional (JAIF, NISA, TEPCO)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Fuel pool cooling functioning Temperature 37.9 C (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

2100 hrs 3/26/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT SIX

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: In vessel (JAIF, NISA, TEPCO)

Core Cooling: Functional (JAIF, NISA, TEPCO)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

Merzke, Daniel

From: Merzke, Daniel
Sent: Friday, April 08, 2011 2:11 PM
To: Hipschman, Thomas; Castleman, Patrick; Snodderly, Michael; Orders, William; Franovich, Mike
Cc: Zorn, Jason
Subject: FW: Status of Spent Fuel Pools at Fukushima
Attachments: 04-07-11 2000 RST Assessment Spent Fuel Pool.docx

I received the attached document from the Ops Center, with the understanding that the CAs had requested this information. As I'm not positive who should be receiving this information, please pass it to whomever you feel the correct party is. Thanks.

Dan

From: RST01 Hoc
Sent: Friday, April 08, 2011 1:57 PM
To: Merzke, Daniel
Subject: Status of Spent Fuel Pools at Fukushima

Dan:

Here is the current status of the spent fuel pools in Japan

Mark

Purpose: Provide a quick view of current RST fuel pool assessment to the NRC Japan team

Stake holder: NRC Japan Team

(b)(4),(b)(5)

General Discussion of the Desired End State of all Spent Fuel Pools

(b)(4),(b)(5)

-
(b)(4),(b)(5)
-

SPENT FUEL POOL STATUS (1400 April 6th)

Fukushima Daiichi Unit 1

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. The

(b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

–
–
–
(b)(4),(b)(5)

Unit 1 Additional Considerations:

– (b)(4),(b)(5)

Fukushima Daiichi Unit 2

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation ration rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full ((b)(6) 4/3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 2 Additional Considerations:

- (b)(4),(b)(5)

Fukushima Daiichi Unit 3

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

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–
–
(b)(4),(b)(5)

Unit 3 Additional Considerations:

– (b)(4),(b)(5)

Fukushima Daiichi Unit 4

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	30°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

-
-

(b)(4),(b)(5)

– (b)(4),(b)(5)

Unit 4 Additional Considerations:

- (b)(4),(b)(5)
-

Fukushima Daiichi Unit 5

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

– (b)(4),(b)(5)
–

Unit 5 Additional Considerations:

– (b)(4),(b)(5)
–

Fukushima Daiichi Unit 6

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

Stable.

Unit 6 Recommendations:

–
–

(b)(4),(b)(5)

Unit 6 Additional Considerations:

–
–

(b)(4),(b)(5)

Fukushima Daiichi Common SFP

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)

Common Additional Considerations:

-
- (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. EPRI recommendations March 18, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(b)(4)	1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi\Industy Spent Fuel Pool Assessment\04-06-11 1200 RST Assessment Spent Fuel Pool.docx

Quayle, Lisa

From: RST01 Hoc
Sent: Saturday, April 09, 2011 11:11 AM
To:
Cc:
(b)(6)
Subject: FW: FINAL - 04-09-11 1200 RST Assessment Spent Fuel Pool Document
Attachments: FINAL - 04-09-11 1200 RST Assessment Spent Fuel Pool.pdf

For your information and comment.

From: RST08 Hoc
Sent: Saturday, April 09, 2011 12:06 PM
To: RST01 Hoc
Subject: FINAL - 04-09-11 1200 RST Assessment Spent Fuel Pool Document

Here is the final version of the RST assessment of the Fukushima Spent Fuel Pools.

The insights and information from this document will be included in the latest revision of the RST Assessment document that is being revised and hopefully issued early next week.

Let me know if you have any questions.

Thanks,

Mike

Mike Brown
Reactor Safety Team

General Discussion of the Desired End State of all Spent Fuel Pools

Purpose: Provide known status and assumptions related to the Fukushima Daiichi spent fuel pools.

Stakeholder: NRC Site team and NISA

(b)(4),(b)(5)

SPENT FUEL POOL STATUS (1400 April 6th)

Fukushima Daiichi Unit 1

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.07 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source: concrete	Periodic fresh water injected via a hose off of a pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting.

(b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

–
–
–

(b)(4),(b)(5)

Unit 1 Additional Considerations:

–

(b)(4),(b)(5)

Fukushima Daiichi Unit 2

Amount of fuel: 587 bundles

Last transfer from Reactor: 116 bundles (September 20-25, 2010)

Decay Heat [megawatt thermal (MWth)]: 0.47 MWth; evaporation ration rate 5240 gallons per day

Fuel Pool Structural Support Integrity: (b)(4),(b)(5)

Fuel Pool Leak Integrity: No data
Criticality status: No data
Fuel Pool Level: Full (b)(6) 4/3)

Water Injection Method and Source: Fresh water injected to the spent fuel pool

Fuel Pool Water Temperature: 71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

-
- (b)(4),(b)(5)
-

Unit 2 Additional Considerations:

- (b)(4),(b)(5)

Fukushima Daiichi Unit 3

Amount of fuel: 514 bundles

Last transfer from Reactor: 148 bundles (June 23 to 28, 2011)

Decay Heat (MWth): 0.23 MWth; evaporation rate 2570 gallons per day

Fuel Pool Structural Support Integrity: Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)

Fuel Pool Leak Integrity: No data
Criticality status: No data
Fuel Pool Level: Full (b)(6) 4/3)

Water Injection Method and Source: concrete
Periodic fresh water injected via a hose off of a pumper truck arm

Fuel Pool Water Temperature: 57°C (JAIF 4/6)

Other:

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 3 Additional Considerations:

- (b)(4),(b)(5)

Fukushima Daiichi Unit 4

Amount of fuel: 1331 bundles

Last transfer from Reactor: 548 bundles (December 5 to December 10, 2010)

Decay Heat (MWth): 1.86 MWth

Fuel Pool Structural Support Integrity: Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)

Fuel Pool Leak Integrity: No data
Criticality status:
Fuel Pool Level: Low water level (b)(6) 4/1)

Water Injection Method and Source: Periodic fresh water injected via a hose off of a concrete pumper truck arm

Fuel Pool Water Temperature: 30°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

- (b)(4),(b)(5)

- (b)(4),(b)(5)
-

Unit 4 Additional Considerations:

- (b)(4),(b)(5)
-

Fukushima Daiichi Unit 5

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

–
–

(b)(4),(b)(5)

Unit 5 Additional Considerations:

–
–

(b)(4),(b)(5)

Fukushima Daiichi Unit 6

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

Stable.

Unit 6 Recommendations:

–
–
(b)(4),(b)(5)

Unit 6 Additional Considerations:

–
–
(b)(4),(b)(5)

Fukushima Daiichi Common SFP

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)

Common Additional Considerations:

-
- (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

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INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. EPRI recommendations March 18, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
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Unit 2		587
Unit 3		514
Unit 4		1, 331
Unit 5	(b)(4)	946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
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Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	–	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi\Industy Spent Fuel Pool Assessment\04-09-11 1200 RST Assessment Spent Fuel Pool.docx

Quayle, Lisa

From: Hay, Michael
Sent: Saturday, April 09, 2011 8:15 PM
To: ET07 Hoc
Cc: Hoc, PMT12; RST01 Hoc; LIA08 Hoc; Collins, Elmo; Casto, Chuck; Brown, Frederick
Subject: RE: Global Assessment
Attachments: Draftpaperrev1.docx

Folks
(b)(5)

Thanks for your support. I plan to work on the RST part, and do the same for that section. Then work on the attachments, etc......

I have not read all these inputs and edited yet so please read everything with a critical eye.

Mike

From: ET07 Hoc
Sent: Saturday, April 09, 2011 5:59 PM
To: Hay, Michael
Cc: Hoc, PMT12; RST01 Hoc; LIA08 Hoc
Subject: Global Assessment

Mike,

Hope all is well there in Japan. The team addresses for reviewing the Global Assessment are:

Liaison Team/International Programs: Lia08.hoc@nrc.gov
Reactor Safety Team: RST01.hoc@nrc.gov
Protective Measures Team: Pmt12.hoc@nrc.gov

I talked with the ET and the other teams and they know this is coming. I have Cc-ed them on this email.

Let me know if you have any problems with this process

Bill
Status Officer

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NEW REACTORS
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

April XX, 2011

SUBJECT: NRC RESPONSE TO FUKUSHIMA EVENT

(b)(5)

(b)(5)

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(b)(5)

From: RST01 Hoc
Sent: Saturday, April 09, 2011 2:17 PM
To: (b)(5)
Subject: Global Assessment Document (aka - RST Assessment)
Attachments: DRAFT 04-09-2011 1000 RST Assessment Document.docx

Team:

Attached is a draft of Revision 2 of the RST assessment. We have tried to combine reactor status, spent fuel pool status, and known plant parameters. This is being issued as a pre-decisional document for your review and comments.

RST Coordinator

RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.

<u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

<u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

Vessel temperatures and pressures:

119 °C at bottom head (increasing) and 246 °C at FW nozzle (steady) (NISA 4/8) (TEPCO 0700 JDT 3/30). RPV ch A=57.3 psig, ch B=115.0 psig both increasing (NISA 4/8), DW and torus pressure at 35 psia (decreasing trend) (TEPCO 0700 JDT 3/30). (This will change daily, along with injection rates, etc- For all units)

Core Cooling: Currently fresh water injection with no boron, injecting through feedwater line at 100 l/min (26.4 gpm) and steady(TEPCO 4/7). (b)(4),(b)(5) (TEPCO); Injection flow rate will be maintained above the minimum debris retention injection rate (MDRIR). Recirculation pump seals have likely failed. (GEH); Injection flow rate above MDRIR could not be maintained through core spray. Assume shutdown cooling system is not available.

RPV structural Integrity: Unknown

Primary Containment: Damage suspected, slow leakage, began injecting nitrogen gas at 1:30 AM JPT on 4/7 (JAIF 4/8). (b)(4),(b)(5)

Dry Well: (b)(4),(b)(5)

Secondary Containment: Severely damaged (hydrogen explosion).

Rad levels: DW 6830 rem/hr and decreasing (NISA 4/8, (b)(4),(b)(5) (b)(4),(b)(5), Torus 1220 rem/hr and steady (NISA 4/8), Outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: On offsite AC power – Control Room lighting for U-1, 2, 3, & 4 (JAIF, 4/1)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(5) shows entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5)
- Vent containment (b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)
    a. To maintain containment pressure below the primary containment pressure limit.
    b. As necessary to maintain RPV injection above MDRIR.
    c.
    d. (b)(4),(b)(5)

(b)(4),(b)(5)

➢

➢

➢ Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

Additional Considerations

A. The following considerations apply to containment venting:

1.

2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect and

(b)(4),(b)(5)

5.

B. Additional Miscellaneous considerations

1.

(b)(4),(b)(5)

(b)(4),(b)(5)

2. Borate water if possible.
3. Ensure spent fuel pool level is maintained as full as possible.
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5)
5. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)
4.
5.

(b)(4),(b)(5)

UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.07 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting.
(b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

- (b)(4),(b)(5)

Unit 1 Additional Considerations:

- (b)(4),(b)(5)

(b)(4),(b)(5)

UNIT TWO CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) Majority of core is probably contained in the reactor vessel. Reactor water level 3/5 TAF (NISA 4/8). (b)(4),(b)(5)

Vessel temperature and pressures: RPV pres: (ch A= -2.9 psig and decreasing , ch B= -2.9 psig and decreasing) (NISA 4/8); RPV temp: Btm Head (not avail) (TEPCo), FW nozzle 141.2°C↓ (NISA 4/8),

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) via fire ext. line using temp. elect pump (b)(6) 4/5). Bottom head temperature 131.6 C, feed water nozzle temperature 172.4 C (TECPO 0700 3/30/11)) Recirculation pump seals have likely failed. (Industry)

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

Drywell pressure reading -0.2 psig↔ (NISA 4/8)

Secondary Containment:

(b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News)

Rad Levels: Drywell 2940 rem/hr↓ (NISA 4/8); Torus 77 rem/hr↔ (NISA 4/8)

Outside plant: 11 mR/hr at gate (variable) (TEPCO 0700 JDT 3/30)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped with the majority located on the core plate and fuel in the lower region of the core is likely encased in salt. However, the amount of salt build-up appears to be less than U-1 based on the reported lower temperatures. (b)(4),(b)(5) Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling flow is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up (b)(5) but is adequately cooled.

The primary containment is damaged

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)
- (b)(4),(b)(5)
-

> (b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.5. below)
    a. To maintain containment pressure below the primary containment pressure limit.
    b. As necessary to maintain RPV injection above MDRIR.
    c.
    d. (b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.4 below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5):
   a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
   b. Radiation monitoring instruments (b)(4),(b)(5)
   c.
   d. (b)(4),(b)(5)
   e.

UNIT 2 - SPENT FUEL POOL STATUS

Amount of fuel: 587 bundles

Last transfer from Reactor: 116 bundles (September 20-25, 2010)

Decay Heat [megawatt thermal (MWth)]: 0.47 MWth; evaporation ration rate 5240 gallons per day

Fuel Pool Structural Support Integrity: (b)(4),(b)(5)

Fuel Pool Leak Integrity: No data
Criticality status: No data
Fuel Pool Level: Full (b)(6) 4/3)

Water Injection Method and Source: Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11

Fuel Pool Water Temperature: 71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

-
- (b)(4),(b)(5)
-

Unit 2 Additional Considerations:

- (b)(4),(b)(5)

(b)(4),(b)(5)

UNIT THREE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) Majority of core is probably contained in reactor vessel; (b)(4),(b)(5)

Vessel temperature and pressure: RPV pressure: ch A= -.6 psig↓ , ch B= -11.4 psig) ↔ (NISA 4/8); RPV temp: Btm Head 110.8°C↔ ; FW nozzle: 88.8°C↔ (NISA 4/8)

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) via fire ext. line using temp. elect pump (b)(6) 4/5), Recirculation pump seals have likely failed.

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

Damage suspected (RST, NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)

Drywell pressure 0.6 psig↔ (NISA 4/8), Torus pressure 10.3 psig↔ (NISA 4/8)

Secondary Containment

Damaged (JAIF, NISA, TEPCO). (b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News)

Spent Fuel Pool

514 bundles (b)(4),(b)(5)

Rad Levels: DW 1880 rem/hr ↔ (NISA 4/8), torus 73.8 rem/hr↔ (NISA 4/8)

Outside plant: 11 mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: On offsite AC power (NISA 4/3). (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Water injection is to the RPV through the RHR system via the recirculation piping, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement has flooded. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
    a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
    b. feedwater system
    c. other systems as they become available
    d. (b)(4),(b)(5)

- (b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.8. below)
    a. To maintain containment pressure below the primary containment pressure limit.
    b. As necessary to maintain RPV injection above MDRIR.
    c. (b)(4),(b)(5)
    d.

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.
5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5):

a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
b. Radiation monitoring instruments (b)(4),(b)(5)
c.
d.

(b)(4),(b)(5)

UNIT 3 - SPENT FUEL POOL STATUS

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

–
–
–

(b)(4),(b)(5)

Unit 3 Additional Considerations:

– (b)(4),(b)(5)

(b)(4),(b)(5)

UNIT FOUR CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling:	Not necessary (JAIF, NISA, TEPCO)
Primary Containment:	Not applicable (JAIF, NISA, TEPCO)
Secondary Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO).

(b)(4),(b)(5)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

1. Maintain coverage of spent fuel pool with fresh borated water.
2. As possible, put spent fuel cooling and cleanup in service.

UNIT 4 - SPENT FUEL POOL STATUS

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm (38 tons of water added on 4/7/11)
Fuel Pool Water Temperature:	57°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

- (b)(4),(b)(5)

- (b)(4),(b)(5)
-

Unit 4 Additional Considerations:

- (b)(4),(b)(5)
-

(b)(4),(b)(5)

UNIT FIVE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .4 psig↔ (NISA 4/8) ; Temp: 45.5°C↑ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) 3/31);

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
946 bundles (JAIF); Temp: 34.7oC↓ (JAIF 4/8); Cooling capability recovered (JAIF 4/1)

Other: (b)(4),(b)(5) External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). (b)(4),(b)(5)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

UNIT 5 - SPENT FUEL POOL STATUS

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

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–
(b)(4),(b)(5)

Unit 5 Additional Considerations:

–
–
(b)(4),(b)(5)

(b)(4),(b)(5)

UNIT SIX CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .7 psig↔ (NISA 4/8) ; Temp: 22.7°C↔ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5);

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
876 bundles (b)(6) Temp: 30.5.0°C↑ (NISA 4/8); Cooling capability recovered (JAIF 4/1). Fuel pool cooling functioning.

Other: (b)(4),(b)(5)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

UNIT 6 - SPENT FUEL POOL STATUS

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

Stable.

Unit 6 Recommendations:

–
–
(b)(4),(b)(5)

Unit 6 Additional Considerations:

–
–
(b)(4),(b)(5)

(b)(4),(b)(5)

COMMON - SPENT FUEL POOL STATUS

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

– (b)(4),(b)(5)

Common Additional Considerations:

–
– (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. EPRI recommendations March 18, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(b)(4)	1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ～ April 2, 2010	64
Unit 2	September 20, 2010 ～ September 25, 2010	116
Unit 3	June 23, 2010 ～ June 28, 2010	148
Unit 4	December 5, 2010 ～ December 10, 2010	548
Unit 5	January 8, 2011 ～ January 13, 2011	120
Unit 6	August 20, 2010 ～ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

From: RST01 Hoc
Sent: Sunday, April 10, 2011 6:44 AM
To: RST06 Hoc
Subject: FW: Global Assessment
Attachments: Draftpaperrev1.docx

From: Hay, Michael
Sent: Saturday, April 09, 2011 9:15 PM
To: ET07 Hoc
Cc: Hoc, PMT12; RST01 Hoc; LIA08 Hoc; Collins, Elmo; Casto, Chuck; Brown, Frederick
Subject: RE: Global Assessment

Folks,
The attached is a "rough" draft of were I'm at with the report. RST input is not done yet, I'll be working it next. Please note the highlighted areas need attention and I indicated who was responsible or if nobody then hopefully HQ can support. If not please let me know so I can figure something out.

Thanks for your support. I plan to work on the RST part, and do the same for that section. Then work on the attachments, etc......

I have not read all these inputs and edited yet so please read everything with a critical eye.

Mike

From: ET07 Hoc
Sent: Saturday, April 09, 2011 5:59 PM
To: Hay, Michael
Cc: Hoc, PMT12; RST01 Hoc; LIA08 Hoc
Subject: Global Assessment

Mike,

Hope all is well there in Japan. The team addresses for reviewing the Global Assessment are:

Liaison Team/International Programs: Lia08.hoc@nrc.gov
Reactor Safety Team: RST01.hoc@nrc.gov
Protective Measures Team: Pmt12.hoc@nrc.gov

I talked with the ET and the other teams and they know this is coming. I have Cc-ed them on this email.

Let me know if you have any problems with this process

Bill
Status Officer

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NEW REACTORS
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

April XX, 2011

SUBJECT: NRC RESPONSE TO FUKUSHIMA EVENT

(b)(5)

(b)(5)

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From: RST02 Hoc
Sent: Sunday, April 10, 2011 5:20 PM
To: RST01 Hoc
Subject: FW: 2011 04-10 global assessment document PMT input
Attachments: 2011 04-10 global assessment document PMT input.docx

Follow Up Flag: Follow up
Flag Status: Flagged

Fyi...

From: Hoc, PMT12
Sent: Sunday, April 10, 2011 4:25 AM
To: RST02 Hoc
Subject: 2011 04-10 global assessment document PMT input

PMT input to Global Assessment Document attached.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NEW REACTORS
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

April XX, 2011

SUBJECT: NRC RESPONSE TO FUKUSHIMA EVENT

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(b)(5)

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From: RST01 Hoc
Sent: Sunday, April 10, 2011 1:04 AM
To: RST10 Hoc
Subject: FW: comments : Global Assessment Document (aka - RST Assessment)

From: Blamey, Alan
Sent: Sunday, April 10, 2011 12:53 AM
To: RST01 Hoc
Subject: FW: comments : Global Assessment Document (aka - RST Assessment)

(b)(5)

From: Bernhard, Rudolph
Sent: Saturday, April 09, 2011 6:50 PM
To: Blamey, Alan; Salay, Michael
Subject: comments : Global Assessment Document (aka - RST Assessment)

Alan:

(b)(5)

I am working on the timeline, and can be reached by cell.

From: RST01 Hoc
Sent: Saturday, April 09, 2011 2:17 PM

(b)(6)

(b)(6)

Subject: Global Assessment Document (aka - RST Assessment)

Team:

Attached is a draft of Revision 2 of the RST assessment. We have tried to combine reactor status, spent fuel pool status, and known plant parameters. This is being issued as a pre-decisional document for your review and comments.

RST Coordinator

From: RST10 Hoc
Sent: Sunday, April 10, 2011 5:52 AM
To: RST06 Hoc; RST07 Hoc; RST01 Hoc
Subject: DRAFT 04-10-2011 0600 RST Assessment Document Rev 3.docx
Attachments: DRAFT 04-10-2011 0600 RST Assessment Document Rev 3.docx

RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2), Based on most recent available data and input from GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.

<u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

<u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

Vessel temperatures and pressures:

119 °C at bottom head (increasing) and 246 °C at FW nozzle (steady) (NISA 4/8) (TEPCO 0700 JDT 3/30). RPV channel A=57.3 psig, channel B=115.0 psig both increasing (NISA 4/8), DW and torus pressure at 35 psia (decreasing trend) (TEPCO 0700 JDT 3/30). (This will change daily, along with injection rates, etc- For all units)

Core Cooling: Currently fresh water injection with no boron, injecting through feedwater line at 100 l/min (26.4 gpm) and steady(TEPCO 4/7). (b)(4),(b)(5) (TEPCO); Injection flow rate will be maintained above the MDRIR. Recirculation pump seals have likely failed. (GEH); Injection flow rate above MDRIR could not be maintained through core spray. Assume shutdown cooling system is not available.

RPV -
Structural Integrity: Unknown

Primary Containment:

Dry Well: (b)(4),(b)(5)

Secondary Containment:
Severely damaged (hydrogen explosion).

Rad levels: DryWell 6830 rem/hr and decreasing (NISA 4/8, (b)(4),(b)(5) (b)(4),(b)(5) Torus 1220 rem/hr and steady (NISA 4/8), Outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: On offsite AC power – Control Room lighting for U-1, 2, 3, & 4 (JAIF, 4/1)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(5) shows entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5)

- Vent containment (b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)
    a. To maintain containment pressure below the primary containment pressure limit.
    b. As necessary to maintain RPV injection above MDRIR.
    c.
    d. (b)(4),(b)(5)

(b)(4),(b)(5)

-
-

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect and
5.

(b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. (b)(4),(b)(5)

2. (b)(4),(b)(5)
3. Ensure spent fuel pool level is maintained as full as possible.
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5)
5. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b) suction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)
4.
5.

UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.07 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting.

(b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 1 Additional Considerations:

- (b)(4),(b)(5)

(b)(4),(b)(5)

UNIT TWO CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4) assemblies – damaged. Majority of core is probably contained in the reactor vessel. Reactor water level 3/5 TAF (NISA 4/8). (b)(4),(b)(5)

Vessel temperature and pressures: RPV pres: (ch A= -2.9 psig and decreasing , ch B= -2.9 psig and decreasing) (NISA 4/8); RPV temp: Btm Head (not avail) (TEPCo), FW nozzle 141.2°C↓ (NISA 4/8),

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) via fire ext. line using temp. elect pump (b)(6) 4/5). Bottom head temperature 131.6 C, feed water nozzle temperature 172.4 C (TECPO 0700 3/30/11)) Recirculation pump seals have likely failed. (Industry)

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

Drywell pressure reading -0.2 psig↔ (NISA 4/8)

Secondary Containment:

(b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News)

Rad Levels: Drywell 2940 rem/hr↓ (NISA 4/8); Torus 77 rem/hr↔ (NISA 4/8)

Outside plant: 11 mR/hr at gate (variable) (TEPCO 0700 JDT 3/30)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. Technicians are continuing to check DC distribution panels.

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped with the majority located on the core plate and fuel in the lower region of the core is likely encased in salt. However, the amount of salt build-up appears to be less than U-1 based on the reported lower temperatures. (b)(4),(b)(5) Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling flow is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up (b)(5) but is adequately cooled.

The primary containment is damaged

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
    a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
    b. feedwater system
    c. other systems as they become available
    d. (b)(4),(b)(5)
- (b)(4),(b)(5)
-

(b)(4),(b)(5)

- ➢

- ➢ Vent containment: (see Additional Considerations A.1. through A.5. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c.
  d. (b)(4),(b)(5)

- ➢ Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.4 below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) uction pressure and Drywell instrument taps
b. Radiation monitoring instruments (b)(4),(b)(5)
c.
d. (b)(4),(b)(5)
e.

UNIT 2 - SPENT FUEL POOL STATUS

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation ration rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 2 Additional Considerations:

- (b)(4),(b)(5)

(b)(4),(b)(5)

UNIT THREE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

Vessel temperature and pressure: RPV pressure: ch A= -.6 psig↓, ch B= -11.4 psig) ↔ (NISA 4/8); RPV temp: Btm Head 110.8°C↔ ; FW nozzle: 88.8°C↔ (NISA 4/8)

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) via fire ext. line using temp. elect pump (b)(6) 4/5), Recirculation pump seals have likely failed.

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

Damage suspected (RST, NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)

Drywell pressure 0.6 psig↔ (NISA 4/8), Torus pressure 10.3 psig↔ (NISA 4/8)

Secondary Containment

Damaged (JAIF, NISA, TEPCO). (b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News)

Spent Fuel Pool

514 bundles – damage suspected (JAIF 3/28); (NISA 4/4) 60°C↑ (b)(4),(b)(5)

Rad Levels: DW 1880 rem/hr ↔ (NISA 4/8), torus 73.8 rem/hr↔ (NISA 4/8)

Outside plant: 11 mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: On offsite AC power (NISA 4/3). (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Water injection is to the RPV through the RHR system via the recirculation piping, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement has flooded. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5)
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)
- (b)(4),(b)(5)
-
-
- Vent containment: (see Additional Considerations A.1. through A.8. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)
  d.
- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
(b)(4),(b)(5)
3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. (b)(4),(b)(5)
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

a. (b)(4),(b)(5) HPCI suction pressure and Drywell instrument taps (b)(4),(b)(5)
b. Radiation monitoring instruments (b)(4),(b)(5)
c.
d. (b)(4),(b)(5)

UNIT 3 - SPENT FUEL POOL STATUS

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

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(b)(4),(b)(5)

Unit 3 Additional Considerations:

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(b)(4),(b)(5)

(b)(4),(b)(5)

UNIT FOUR CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling:	Not necessary (JAIF, NISA, TEPCO)
Primary Containment:	Not applicable (JAIF, NISA, TEPCO)
Secondary Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO). (b)(4),(b)(5)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

1. (b)(4),(b)(5)
2. As possible, put spent fuel cooling and cleanup in service.

UNIT 4 - SPENT FUEL POOL STATUS

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm (38 tons of water added on 4/7/11)
Fuel Pool Water Temperature:	57°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

– (b)(4),(b)(5)

- (b)(4),(b)(5)
-

Unit 4 Additional Considerations:

- (b)(4),(b)(5)
-

(b)(4),(b)(5)

UNIT FIVE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .4 psig↔ (NISA 4/8) ; Temp: 45.5°C↑ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) 3/31);

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
946 bundles (JAIF); Temp: 34.7oC↓ (JAIF 4/8); Cooling capability recovered (JAIF 4/1)

Other: On offsite AC power (b)(6) 3/28). External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). (b)(4),(b)(5)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

UNIT 5 - SPENT FUEL POOL STATUS

Amount of fuel: 946 bundles

Last transfer from Reactor: 120 bundles (January 8-13, 2011)

Decay Heat (MW): 0.8 MW (b)(6)

Fuel Pool Structural Support Integrity: Not damaged (JAIF 4/4)

Fuel Pool Leak Integrity: No data
Criticality status: No data
Fuel Pool Level: Full

Water Injection Method and Source: Fuel pool cooling

Fuel Pool Water Temperature: 37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

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(b)(4),(b)(5)

Unit 5 Additional Considerations:

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(b)(4),(b)(5)

(b)(4),(b)(5)

UNIT SIX CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .7 psig↔ (NISA 4/8) ; Temp: 22.7°C↔ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
876 bundles (b)(6) Temp: 30.5.0°C↑ (NISA 4/8); Cooling capability recovered (JAIF 4/1). Fuel pool cooling functioning.

Other: (b)(4),(b)(5)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

UNIT 6 - SPENT FUEL POOL STATUS

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

Stable.

Unit 6 Recommendations:

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(b)(4),(b)(5)

Unit 6 Additional Considerations:

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–
(b)(4),(b)(5)

(b)(4),(b)(5)

COMMON - SPENT FUEL POOL STATUS

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)

Common Additional Considerations:

-
- (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. EPRI recommendations March 18, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(b)(4)	1,331
Unit 5		946
Unit 6		876
Shared pool		6,375
total		10,921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1,180

Note: Attachment 1 is Detailed Contents of Each Pool.

Esmaili, Hossein

From: Esmaili, Hossein
Sent: Monday, April 11, 2011 8:18 AM
To: Notafrancesco, Allen
Subject: FW: Nitrogen injection graph
Attachments: Nitrogen curve img-409154535.pdf

From: Lee, Richard
Sent: Monday, April 11, 2011 8:16 AM
To: Esmaili, Hossein
Subject: FW: Nitrogen injection graph

fyi

From: Salay, Michael
Sent: Monday, April 11, 2011 1:11 AM
To: RST01 Hoc; Lee, Richard; 'Gauntt, Randall O'
Subject: FW: Nitrogen injection graph

(b)(4),(b)(5)

Thanks,
-Mike
Japan Site Team

From: Blamey, Alan
Sent: Sunday, April 10, 2011 7:48 AM
To: Salay, Michael; Bernhard, Rudolph
Subject: FW: Nitrogen injection graph

From: Gard, Lee A (INPO) [mailto: (b)(6)]
Sent: Saturday, April 09, 2011 8:51 AM
To: Blamey, Alan
Subject: Nitrogen injection graph

Al-

(b)(4)

Lee Gard
INPO
cell (b)(6)
gardla@inpo.org

(b)(4)

From: RST01 Hoc
Sent: Monday, April 11, 2011 12:06 AM
To: RST08 Hoc; RST07 Hoc; RST06 Hoc
Subject: FW: Marked up Spent Fuel Pools doc
Attachments: 04-07-11 2000 RST Assessment Spent Fuel PoolJSTmods.docx

From: Salay, Michael
Sent: Monday, April 11, 2011 12:04 AM
To: RST01 Hoc
Subject: FW: Marked up Spent Fuel Pools doc

Japan Team RSST comments on the SFP paper "General Discussion of the Desired End State of all Spent Fuel Pools" attached. Note that these comments were made to the next to last version.

Mike Salay
NRC Japan Team

From: Salay, Michael
Sent: Saturday, April 09, 2011 4:53 AM
To: Blamey, Alan
Subject: Marked up Spent Fuel Pools doc

Attached. -Mike

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

~~OFFICIAL USE ONLY~~

Purpose:	Provide a quick view of current RST fuel pool assessment to the NRC Japan team
Stake holder:	NRC Japan Team

(b)(4),(b)(5)

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The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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(b)(4),(b)(5)

(b)(5)

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SPENT FUEL POOL STATUS (1400 April 6th)

Fukushima Daiichi Unit 1

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

(b)(5)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. The (b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 1 Additional Considerations:

(b)(5)

- (b)(4),(b)(5)

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Fukushima Daiichi Unit 2

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation ration rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)

(b)(5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 2 Additional Considerations:

(b)(5)

- (b)(4),(b)(5)

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Fukushima Daiichi Unit 3

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28) (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	

(b)(5)

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

-
- (b)(4),(b)(5)
-

Unit 3 Additional Considerations:

(b)(5)

- (b)(4),(b)(5)

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The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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Fukushima Daiichi Unit 4

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	30°C (JAIF 4/4)

(b)(5)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

- (b)(4),(b)(5)
-

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- (b)(4),(b)(5)

Unit 4 Additional Considerations:

(b)(5)

-
- (b)(4),(b)(5)

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Fukushima Daiichi Unit 5

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

(b)(4),(b)(5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

-
-

(b)(4),(b)(5)

Unit 5 Additional Considerations:

-
-

(b)(4),(b)(5)

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Fukushima Daiichi Unit 6

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

(b)(5)

Other: External AC power supplying the unit. Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

Stable.

Unit 6 Recommendations:

- (b)(4),(b)(5)
-

Unit 6 Additional Considerations:

- (b)(4),(b)(5)
-

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Fukushima Daiichi Common SFP

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)

Common Additional Considerations:

-
- (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

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ENCLOSURE 1

1. **EPRI recommendations March 18, 2011**

(b)(4),(b)(5)

(b)(5)

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(b)(4),(b)(5)

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ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(5)

(b)(5)

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(b)(5)

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ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1	(b)(4)	292
Unit 2		587
Unit 3		514
Unit 4		1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	–	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi\Industy Spent Fuel Pool Assessment\04-06-11 1200 RST Assessment Spent Fuel Pool.docx

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From: Hoc, PMT12
Sent: Monday, April 11, 2011 1:00 PM
To: OST01 HOC
Subject: FW: PARs for Deputies Meeting Rev 16
Attachments: PARs for Deputies Meeting Rev 16.docx

From: Hoc, PMT12
Sent: Monday, April 11, 2011 11:12 AM
To: Virgilio, Martin; RST01 Hoc; OST02 HOC
Cc: Milligan, Patricia
Subject: PARs for Deputies Meeting Rev 16

This is Rev 16 of the Composite Document and it contains Trish Milligan's latest comments, for your review.

Guidance for Return (Permanent Re-entry) of US Citizens to Areas around Fukushima Daiichi NPP

(b)(5)

(b)(4)

(b)(5)

(b)(5)

(b)(5)

(b)(5)

From: RST08 Hoc
Sent: Monday, April 11, 2011 4:31 AM
To: RST01 Hoc
Cc: RST06 Hoc
Subject: RST Assessment Document, Rev.2
Attachments: DRAFT 04-11-2011 0600 RST Assessment Document Rev 2.docx

Here is the updated RST Assessment document as of 4/11/11 at 0600. It has incorporated the latest spent fuel pool assessment document and the plant stability document.
Thanks,
Tim Kolb

RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2), Based on most recent available data and input from GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

(b)(5)

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.

<u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

<u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

Vessel temperatures and pressures:

119 °C at bottom head (increasing) and 246 °C at FW nozzle (steady) (NISA 4/8) (TEPCO 0700 JDT 3/30). RPV channel A=57.3 psig, channel B=115.0 psig both increasing (NISA 4/8), DW and torus pressure at 35 psia (decreasing trend) (TEPCO 0700 JDT 3/30). (This will change daily, along with injection rates, etc- For all units)

Core Cooling: Currently fresh water injection with no boron, injecting through feedwater line at 100 l/min (26.4 gpm) and steady(TEPCO 4/7). (b)(4),(b)(5) (TEPCO); Injection flow rate will be maintained above the MDRIR. Recirculation pump seals have likely failed. (GEH); Injection flow rate above MDRIR could not be maintained through core spray. Assume shutdown cooling system is not available.

RPV -
Structural Integrity: Unknown

Primary Containment:

(b)(4),(b)(5)

Dry Well: Dry well pressure 12.1 psig and increasing (NISA 4/8). Torus press. 7.8 psig and increasing (NISA 4/8). (b)(4),(b)(5)

Secondary Containment:
Severely damaged (hydrogen explosion).

Rad levels: DryWell 6830 rem/hr and decreasing (NISA 4/8, INPO attributes this to a failed instrument), Torus 1220 rem/hr and steady (NISA 4/8). Outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: On offsite AC power – Control Room lighting for U-1, 2, 3, & 4 (JAIF, 4/1)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(5) shows entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5)
- Vent containment (b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)
  d.

(b)(4),(b)(5)

-
-
- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect and
5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. (b)(4),(b)(5)

2. (b)(4),(b)(5)
3. Ensure spent fuel pool level is maintained as full as possible.
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5)
5. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b) suction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)
4.
5.

UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available: equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting.
(b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

- (b)(4),(b)(5)

Unit 1 Additional Considerations:

- (b)(4),(b)(5)

(b)(4),(b)(5)

UNIT TWO CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) Majority of core is probably contained in the reactor vessel. Reactor water level 3/5 TAF (NISA 4/8). (b)(4),(b)(5)

(b)(4),(b)(5)

Vessel temperature and pressures: RPV pres: (ch A= -2.9 psig and decreasing , ch B= -2.9 psig and decreasing) (NISA 4/8); RPV temp: Btm Head (not avail) (TEPCo), FW nozzle 141.2°C↓ (NISA 4/8),

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) (b)(4),(b)(5)

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

Drywell pressure reading -0.2 psig↔ (NISA 4/8)

Secondary Containment:

(b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News)

Rad Levels: Drywell 2940 rem/hr↓ (NISA 4/8); Torus 77 rem/hr↔ (NISA 4/8)

Outside plant: 11 mR/hr at gate (variable) (TEPCO 0700 JDT 3/30)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped with the majority located on the core plate and fuel in the lower region of the core is likely encased in salt. However, the amount of salt build-up appears to be less than U-1 based on the reported lower temperatures. (b)(4),(b)(5) Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling flow is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up (b)(5) but is adequately cooled.

The primary containment is damaged

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5)
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)

- (b)(4),(b)(5)
-

(b)(4),(b)(5)

➢ Vent containment: (see Additional Considerations A.1. through A.5. below)
   a. To maintain containment pressure below the primary containment pressure limit.
   b. As necessary to maintain RPV injection above MDRIR.
   c.
   d. (b)(4),(b)(5)

➢ Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.4 below)

Additional Considerations

A. The following considerations apply to containment venting:

1.

2.

3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
b. Radiation monitoring instruments (b)(4),(b)(5)
c.
d. (b)(4),(b)(5)
e.

UNIT 2 - SPENT FUEL POOL STATUS

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)
-
-
-

Unit 2 Additional Considerations:

- (b)(4),(b)(5)
-

(b)(4),(b)(5)

UNIT THREE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

Vessel temperature and pressure: RPV pressure: ch A= -.6 psig↓ , ch B= -11.4 psig) ↔ (NISA 4/8); RPV temp: Btm Head 110.8°C↔ ; FW nozzle: 88.8°C↔ (NISA 4/8)

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) (b)(4),(b)(5) (b)(4),(b)(5) Recirculation pump seals have likely failed.

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

Damage suspected (RST, NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)

Drywell pressure 0.6 psig↔ (NISA 4/8), Torus pressure 10.3 psig↔ (NISA 4/8)

Secondary Containment

Damaged (JAIF, NISA, TEPCO). (b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News)

Spent Fuel Pool

514 bundles (b)(4),(b)(5)

Rad Levels: DW 1880 rem/hr ↔ (NISA 4/8), torus 73.8 rem/hr↔ (NISA 4/8)

Outside plant: 11 mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: On offsite AC power (NISA 4/3). (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Water injection is to the RPV through the RHR system via the recirculation piping, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement has flooded. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)

-
-
- (b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.8. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c.
  d. (b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.
5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. (b)(4),(b)(5)
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
b. Radiation monitoring instruments (b)(4),(b)(5)
c.
d.

(b)(4),(b)(5)

UNIT 3 - SPENT FUEL POOL STATUS

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm. 80 tons added on 4/10.
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

- (b)(4),(b)(5)
-
-
-

Unit 3 Additional Considerations:

- (b)(4),(b)(5)
-

(b)(4),(b)(5)

UNIT FOUR CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)

Core Cooling: Not necessary (JAIF, NISA, TEPCO)

Primary Containment: Not applicable (JAIF, NISA, TEPCO)

Secondary Containment: Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO). [redacted] (b)(4),(b)(5)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

1. Maintain coverage of spent fuel pool with fresh water. [redacted] (b)(4),(b)(5)
2. As possible, put spent fuel cooling and cleanup in service.

UNIT 4 - SPENT FUEL POOL STATUS

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm (38 tons of water added on 4/7/11)
Fuel Pool Water Temperature:	30°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

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(b)(4),(b)(5)

–
–
–

Unit 4 Additional Considerations:

(b)(4),(b)(5)

(b)(4),(b)(5)

UNIT FIVE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .4 psig↔ (NISA 4/8) ; Temp: 45.5°C↑ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) 3/31);

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
946 bundles (JAIF); Temp: 34.7oC↓ (JAIF 4/8); Cooling capability recovered (JAIF 4/1)

Other: On offsite AC power (b)(6) 3/28). External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). (b)(4),(b)(5)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

UNIT 5 - SPENT FUEL POOL STATUS

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

– Unit 5 is stable with cooling capacity recovered.

Unit 5 Recommendations:

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–

(b)(4),(b)(5)

Unit 5 Additional Considerations:

–
–

(b)(4),(b)(5)

(b)(4),(b)(5)

UNIT SIX CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

(b)(4),(b)(5)

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5)
(b)(4),(b)(5)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
876 bundles (b)(6) Temp: 30.5.0°C↑ (NISA 4/8): Cooling capability recovered (JAIF 4/1). Fuel pool cooling functioning.

Other: (b)(4),(b)(5)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

UNIT 6 - SPENT FUEL POOL STATUS

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

- Unit 6 is stable with cooling capacity recovered.

Unit 6 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 6 Additional Considerations:

- (b)(4),(b)(5)
-

(b)(4),(b)(5)

COMMON - SPENT FUEL POOL STATUS

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

–
– (b)(4),(b)(5)

Common Additional Considerations:

–
– (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company

~~ENCLOSURE 1~~

1. **EPRI recommendations March 18, 2011**

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 24, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1	(b)(4)	292
Unit 2		587
Unit 3		514
Unit 4		1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

From: RST01 Hoc
Sent: Wednesday, April 13, 2011 9:40 PM
To: Hiland, Patrick
Cc: ET01 Hoc
Subject: RST Assessment Rev 2
Attachments: FW: NR Comments on RST Rev 2; DRAFT 04-12-2011 1200 RST Assessment Document Rev 2GEH_INPO_DOE.docx

Mr. Hiland,

Attached is the RST Assessment Rev 2 which has GEH, INPO, and DOE comments. In addition, we included the email from NR which has their comments which have not been fully incorporated as of yet.

Regards,
RST Team

RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2).
Based on most recent available data and input from GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

(b)(4),(b)(5)

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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(b)(4),(b)(5)

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(b)(4),(b)(5)

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(b)(4),(b)(5)

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.

<u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

<u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assessment: (As of 0700, 4/12/11)

RPV Pressure (Mpag)

A – 0.416, steady (60.3 psig)

B – 0.908, rising (131.7 psig)

RPV Temperature (°C)

Bottom Head – 119, steady (246.2°F)

Feedwater Nozzle – 216.2 and lowering (421.2°F)

PCV Pressure (MPaa)

DW – 0.19 (27.6 psia)

SC – 0.165 (23.9 psia) rising

DW CAMS (Sv/hr) – INOP

S/C CAMS (Sv/hr) – 10.8 (1080 rem/hr) lowering

Containment Atmosphere – Inert, Nitrogen injection in progress

(b)(4),(b)(5)

Core Status: (b)(4),(b)(5) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

Core Cooling: Recirculation pump seals have likely failed. (GEH); Injection flow rate above MDRIR could not be maintained through core spray. Assume shutdown cooling system is not available.

RPV -
Structural Integrity: Unknown

Primary Containment:
Damage suspected, slow leakage, (b)(4),(b)(5)

Secondary Containment:
Severely damaged (hydrogen explosion).

Rad levels: Outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: On offsite AC power – Control Room lighting for U-1, 2, 3, & 4 (JAIF, 4/1)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(5) shows entire fuel floor covered by grey-brown debris of building roof.

The primary containment is potentially damaged (b)(4),(b)(5)

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

The following priorities are consistent with SAMG guidelines.

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5)
- Vent containment (b)(4),(b)(5) (See Additional Considerations A.1 through A.5 below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.

(b)(4),(b)(5)

- (b)(4),(b)(5)
- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations B~~C~~.1. through C.~~4~~5 below).

Additional Considerations

A. The following considerations apply to containment venting:

1. (b)(4),(b)(5)
2.
3.
4. Spray water on steam plumes and planned containment vents for scrubbing effect and (b)(4),(b)(5)
5.

B. Additional Miscellaneous considerations

1. (b)(4),(b)(5)
2.
3. Ensure spent fuel pool level is maintained as full as possible.
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5)
5. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPC (b)(4),(b)(5) ction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)
4.
5.

UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.07 MWth (b)(6) evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting.
(b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

- (b)(4),(b)(5)

Unit 1 Additional Considerations:

- (b)(4),(b)(5)

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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(b)(4),(b)(5)

UNIT TWO CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assessment: (As of 0700, 4/12/11)

RPV Pressure (MPag)
A – (-.023), steady (-3.3 psig)
B – (-0.025), steady (-3.6 psig)
RPV Temperature (°C)
Bottom Head – 208.1, steady (406°F)
Feedwater Nozzle – 165.8 and lowering (330°F)
PCV Pressure (MPaa)
DW – 0.09 (13.1 psia)
SC – unknown
DW CAMS (Sv/hr) – 28.1 (2810 rem/hr)
S/C CAMS (Sv/hr) – .68 (68 rem/hr)
Containment Atmosphere – Unknown, nitrogen injection scheduled to begin 4/20/11

(b)(4),(b)(5)

Core Status: (b)(4),(b)(5) Majority of core is probably contained in the reactor vessel. Reactor water level 3/5 TAF (NISA 4/8). (b)(4),(b)(5)

(b)(4),(b)(5)

Core Cooling: Recirculation pump seals have likely failed. (Industry)

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Damage and leakage suspected (JAIF, NISA, TEPCO) (INPO)

Secondary Containment:

(b)(4),(b)(5)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped with the majority located on the core plate and fuel in the lower region of the core is likely encased in salt. However, the amount of salt build-up appears to be less than U-1 based on the reported lower temperatures. (b)(4),(b)(5) Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling flow is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up (b)(5) but is adequately cooled.

(b)(4),(b)(5)

The primary containment is damaged

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5)
    a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
    b. feedwater system
    c. other systems as they become available

(b)(4),(b)(5)

➢ (b)(4),(b)(5)

➢ Vent containment: (see Additional Considerations A.1. through A.5. below)
   a. To maintain containment pressure below the primary containment pressure limit.
   b. As necessary to maintain RPV injection above MDRIR.
   c. To flood primary containment.
   d. (b)(4),(b)(5)

➢ Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations ~~C.1~~B.4. through C.4-5 below)

Additional Considerations

A. The following considerations apply to containment venting:

1\.
2\.
3\.
(b)(4),(b)(5)

4\. Spray water on steam plumes and planned containment vents for scrubbing effect.

5\. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1\. Borate water if possible.

2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

~~a.~~1 (b)(4),(b)(5) HPC (b)(4),(b)(5) ction pressure and Drywell instrument taps.

~~b.~~2. Radiation monitoring instruments (b)(4),(b)(5)

~~c.~~3
~~d.~~4 (b)(4),(b)(5)
~~e.~~5

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UNIT 2 - SPENT FUEL POOL STATUS

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.5 MWth; (b)(6) evaporation rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 1/3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11
Fuel Pool Water Temperature:	46°C (TEPCO 4/12)

Other: External AC power has reached the unit; checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

-
-
-
-

(b)(4),(b)(5)

Unit 2 Additional Considerations:

-
-

(b)(4),(b)(5)

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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(b)(4),(b)(5)

UNIT THREE CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assessment: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – (-.019), steady (-2.8 psig)

B – (-0.079), steady (-11.5 psig)

RPV Temperature (°C)

Bottom Head – 105, steady (222°F)

Feedwater Nozzle – 105.4 and lowering (221.7°F)

PCV Pressure (MPaa)

DW – 0.105 (15.3 psia)

SC – .1692 (24.5 psia)

DW CAMS (Sv/hr) – 17.4 (1740 rem/hr)

S/C CAMS (Sv/hr) – .67 (67 rem/hr)

Containment Atmosphere – Unknown

(b)(4),(b)(5)

Core Status: (b)(4),(b)(5)

Core Cooling: Recirculation pump seals have likely failed.

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

Damage suspected (RST, NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)

Secondary Containment

Damaged (JAIF, NISA, TEPCO). Severe damage from H_2 explosion.

Spent Fuel Pool

514 bundles (b)(4),(b)(5)

Other: On offsite AC power (NISA 4/3). (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Water injection is to the RPV through the RHR system via the recirculation piping, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement has flooded. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5)
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available

(b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.8. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.

c.
d. (b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations ~~C.1~~B.4. through C.~~3~~5. below)

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.
3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.
5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. (b)(4),(b)(5)
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5)
(b)(4),(b)(5)
~~C.~~
~~a.~~1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) ction pressure and Drywell instrument taps

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~~b.~~2. Radiation monitoring instruments (b)(4),(b)(5)

~~c.~~3

4. (b)(4),(b)(5)

~~d.~~5

UNIT 3 - SPENT FUEL POOL STATUS

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, ~~2011~~2010)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) ~~1/3)~~
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm, 80 tons added on 4/10.
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

- (b)(4),(b)(5)
-
-
-

Unit 3 Additional Considerations:

- (b)(4),(b)(5)
-

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

~~OFFICIAL USE ONLY~~

(b)(4),(b)(5)

UNIT FOUR CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling:	Not necessary (JAIF, NISA, TEPCO)
Primary Containment:	Not applicable (JAIF, NISA, TEPCO)
Secondary Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO). [redacted] (b)(4),(b)(5)

~~**ASSESSMENT:**~~

~~Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc-water reaction could have continued, resulting in a major source term release.~~

~~Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).~~

~~**RECOMMENDATIONS:**~~

1. ~~Maintain coverage of spent fuel pool with fresh water. Boron used as necessary to control criticality with consideration of pH and boron solubility limitations.~~
2. ~~As possible, put spent fuel cooling and cleanup in service.~~

UNIT 4 - SPENT FUEL POOL STATUS

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	2.3 MWth (b)(6) evaporation rate 20,000 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Low water level (b)(6) /1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm (38 tons of water added on 4/7/11)
Fuel Pool Water Temperature:	30°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

(b)(4),(b)(5)

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<u>Unit 4 Additional Considerations:</u>

(b)(4),(b)(5)

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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(b)(4),(b)(5)

UNIT FIVE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .4 psig↔ (NISA 4/8) ; Temp: 45.5°C↑ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) 3/31);

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
946 bundles (JAIF); Temp: 34.7oC↓ (JAIF 4/8); Cooling capability recovered (JAIF 4/1)

Other: On offsite AC power (IAEA 3/28). External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). (b)(4),(b)(5)

ASSESSMENT:

Unit five is ~~relatively~~ stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

UNIT 5 - SPENT FUEL POOL STATUS

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

- Unit 5 is stable with cooling capacity recovered.

Unit 5 Recommendations:

-
-
-

(b)(4),(b)(5)

Unit 5 Additional Considerations:

-
-

(b)(4),(b)(5)

(b)(4),(b)(5)

UNIT SIX CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .7 psig↔ (NISA 4/8) ; Temp: 22.7°C↔ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO) (b)(4),(b)(5) (b)(4),(b)(5)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
876 bundles (b)(6) Temp: 30.5.0°C↑ (NISA 4/8); Cooling capability recovered (JAIF 4/1). Fuel pool cooling functioning.

Other: On offsite AC power (b)(4),(b)(5)

ASSESSMENT:

Unit Six is ~~relatively~~ stable.

RECOMMENDATIONS:

1. Monitor.

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

UNIT 6 - SPENT FUEL POOL STATUS

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

- Unit 6 is stable with cooling capacity recovered.

Unit 6 Recommendations:

-
-
-

(b)(4),(b)(5)

Unit 6 Additional Considerations:

-
-

(b)(4),(b)(5)

(b)(4),(b)(5)

COMMON - SPENT FUEL POOL STATUS

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)
-

Common Additional Considerations:

- (b)(4),(b)(5)
-

REFERENCES

1. EPRI recommendations March 18, 2011 (b)(5)
2. SFP Criticality Potential, Kent Wood, March 24, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. **EPRI recommendations March 18, 2011**

(b)(4),(b)(5)

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 24, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(b)(4)	1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

From: RST01 Hoc
Sent: Tuesday, April 26, 2011 2:36 AM
To: Hiland, Patrick; Skeen, David
Cc: RST02 Hoc; OST01 HOC; Johnson, Michael; Uhle, Jennifer; Carpenter, Cynthia; Casto, Chuck; Reynolds, Steven; Kokajko, Lawrence; Correia, Richard; Tracy, Glenn; Dudes, Laura
Subject: Revision of RST Assessment Document to align w/ TEPCO Roadmap Document
Attachments: RST Assessment Document rev 2 4-26-2011.docx; April 23 roadmap assessment Rev 2 Skeen CN.docx

Pat & Dave,

(b)(5)

RST 01, See-Meng Wong, Kirby Scales.

RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2),
Based on most recent available data and input from industry and government sources

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units (REV 2),

Based on most recent available data and input from industry and government sources

1400 April 22, 2011

Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.

<u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

<u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assumptions: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – 0.416, steady (60.3 psig)

B – 0.908, rising (131.7 psig)

RPV Temperature (°C)

Bottom Head – 119, steady (246.2°F)

Feedwater Nozzle – 216.2 and lowering (421.2°F)

PCV Pressure (MPaa)

DW – 0.19 (27.6 psia)

SC – 0.165 (23.9 psia) rising

DW CAMS (Sv/hr) – INOP

S/C CAMS (Sv/hr) – 10.8 (1080 rem/hr) lowering

Containment Atmosphere – Inert, Nitrogen injection in progress

Other Information:

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

(b)(4),(b)(5)

(b)(4),(b)(5)

Reactor water level: (b)(4),(b)(5)
(b)(4),(b)(5) Recirculation pump seals have likely failed (GEH).

Core Status: (b)(4),(b)(5)
(b)(4),(b)(5) the volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

RPV Structural Integrity: Unknown

Assessment:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt. Core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but providing limited if any flow past the fuel. It is difficult to determine how much cooling is getting to the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded ~~by~~ core damage. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Secondary Containment: Severely damaged (hydrogen explosion). (b)(5) (b)(5) shows entire fuel floor covered by grey-brown debris of building roof.

(b)(4),(b)(5)

Rad levels outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

➢ (b)(4),(b)(5)

➢

➢ Inject into the RPV with all available resources (b)(4),(b)(5)

(b)(4),(b)(5)

➢ Vent containment (b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)

a. To maintain containment pressure below the primary containment pressure limit.
b. As necessary to maintain RPV injection above MDRIR.
c.
d. (b)(4),(b)(5)

➢ (b)(4),(b)(5)

➢

➢ Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The short-term goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations B.1. through C.5 below).

(b)(4),(b)(5)

(b)(4),(b)(5)

Additional Considerations:

A. The following considerations apply to containment venting:

1.

2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect

(b)(4),(b)(5)

5.

B. Additional Miscellaneous considerations

1.

(b)(4),(b)(5)

2.

3. Ensure spent fuel pool level is maintained as full as possible.

4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5)

5. (b)(4),(b)(5)

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)
4.
5.

UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.07 MWth (b)(6) evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting.

(b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 SFP Recommendations:

(b)(4),(b)(5)

Unit 1 SFP Additional Considerations:

(b)(4),(b)(5)

– (b)(4),(b)(5)

UNIT TWO CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assumptions: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – (-.023), steady (-3.3 psig)

B – (-0.025), steady (-3.6 psig)

RPV Temperature (°C)

Bottom Head – 208.1, steady (406°F)

Feedwater Nozzle – 165.8 and lowering (330°F)

PCV Pressure (MPaa)

DW – 0.09 (13.1 psia)

SC – unknown

DW CAMS (Sv/hr) – 28.1 (2810 rem/hr)

S/C CAMS (Sv/hr) – .68 (68 rem/hr)

Containment Atmosphere – Unknown, nitrogen injection scheduled to begin 4/20/11

Other Information: External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Assessment:
Damaged fuel may have slumped with the majority located on the core plate. Fuel in the lower region of the core is likely encased in salt, though the lower temperatures reported indicate that the amount of salt build-up is likely less than in Unit 1. (b)(4),(b)(5)

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. (b)(4),(b)(5) Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height, though (b)(4),(b)(5) Natural circulation believed impeded by core damage. (b)(4),(b)(5) (b)(4),(b)(5) Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

(b)(4),(b)(5)

Primary Containment: Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

- (b)(4),(b)(5)
- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5)
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. (b)(4),(b)(5)
- (b)(4),(b)(5)
- Vent containment: (see Additional Considerations A.1. through A.5. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)
  d.
- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The short-term goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations B.4. through C.5 below)

(b)(4),(b)(5)

(b)(4),(b)(5)

Additional Considerations

A. The following considerations apply to containment venting:

1.

2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.

2. Ensure spent fuel pool level is maintained as full as possible.

3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.

4. (b)(4),(b)(5)

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps

2. Radiation monitoring instruments (b)(4),(b)(5)

3. (b)(4),(b)(5)

4.

5.

UNIT 2 - SPENT FUEL POOL STATUS

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.5 MWth; (b)(6) evaporation rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11
Fuel Pool Water Temperature:	46°C (TEPCO 4/12)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

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–
–
–

(b)(4),(b)(5)

Unit 2 Additional Considerations:

–
–

(b)(4),(b)(5)

UNIT THREE CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assessment: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – (-.019), steady (-2.8 psig)

B – (-0.079), steady (-11.5 psig)

RPV Temperature (°C)

Bottom Head – 105, steady (222°F)

Feedwater Nozzle – 105.4 and lowering (221.7°F)

PCV Pressure (MPaa)

DW – 0.105 (15.3 psia)

SC – .1692 (24.5 psia)

DW CAMS (Sv/hr) – 17.4 (1740 rem/hr)

S/C CAMS (Sv/hr) – .67 (67 rem/hr)

Containment Atmosphere – Unknown

Other Information: On offsite AC power (NISA 4/3).

(b)(4),(b)(5)

(b)(4),(b)(5)

Assessment:
Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, though the lower reported temperatures indicate that the amount of salt build-up is likely less than in Unit 1. Nonetheless, core flow capability is in jeopardy due to the salt build up (b)(4),(b)(5)

Water injection is to the RPV is occurring through the RHR system via the recirculation piping, but with limited flow past the fuel. (b)(4),(b)(5) (b)(4),(b)(5) ater flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height, though core flow capability may be affected due to continued salt build up. Natural circulation is believed to be impeded by core damage. (b)(4),(b)(5) (b)(4),(b)(5) Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

(b)(4),(b)(5)

Primary Containment: Damage suspected (RST, NISA, TEPCO)

(b)(4),(b)(5)

(b)(4),(b)(5)

Secondary Containment: Damaged (JAIF, NISA, TEPCO). (b)(4),(b)(5) (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
    a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
    b. feedwater system
    c. other systems as they become available

-
-
-

(b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.5. below)
    a. To maintain containment pressure below the primary containment pressure limit.
    b. As necessary to maintain RPV injection above MDRIR.
    c. (b)(4),(b)(5)
    d.

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The short-term goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations B.4. through C.5. below).

(b)(4),(b)(5)

Additional Considerations:

A. The following considerations apply to containment venting:

1.

2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. (b)(4),(b)(5)

2. Ensure spent fuel pool level is maintained as full as possible.

3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.

4. (b)(4),(b)(5)

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps

2. Radiation monitoring instruments (b)(4),(b)(5)

3. (b)(4),(b)(5)

4.

5.

UNIT 3 - SPENT FUEL POOL STATUS

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2010)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm. 80 tons added on 4/10.
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	External AC power has reached the unit

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

- (b)(4),(b)(5)
-
-
-

Unit 3 Additional Considerations:

- (b)(4),(b)(5)

– (b)(4),(b)(5)

UNIT FOUR CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Core Status: Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)

Core Cooling: Not necessary (JAIF, NISA, TEPCO)

Primary Containment: Not applicable (JAIF, NISA, TEPCO)

Secondary Containment: Severely damaged in hydrogen explosion. (JAIF, NISA, TEPCO)

Rad Levels: No information

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO).

Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

UNIT 4 - SPENT FUEL POOL STATUS

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	2.3 MWth (b)(6) evaporation rate 20,000 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm (38 tons of water added on 4/7/11)
Fuel Pool Water Temperature:	30°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

(b)(4),(b)(5)

Unit 4 Recommendations:

- (b)(4),(b)(5)

Unit 4 Additional Considerations:

- (b)(4),(b)(5)

UNIT FIVE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

RPV: Pressure .4 psig (NISA 4/8); Temp: 45.5°C (NISA 4/8)

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5)

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment: Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool: 946 bundles (JAIF); Temp: 34.7oC↓ (JAIF 4/8)
Cooling capability recovered and functioning (JAIF 4/1)

Other: On offsite AC power (b)(6) 3/28).

ASSESSMENT:

Unit five is stable.

RECOMMENDATIONS:

- Monitor

UNIT 5 - SPENT FUEL POOL STATUS

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling temporarily lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

– Unit 5 is stable with cooling capacity recovered.

Unit 5 Recommendations:

> (b)(4),(b)(5)

Unit 5 Additional Considerations:

– (b)(4),(b)(5)

UNIT SIX CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

RPV: Pressure .7 psig (NISA 4/8); Temp: 22.7°C (NISA 4/8)

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5)

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment: Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool: 876 bundles (b)(6)
Temp: 30.5.0°C (NISA 4/8)
Cooling capability recovered and functioning (JAIF 4/1).

Other: On offsite AC power (b)(6) 3/28)

ASSESSMENT:

Unit Six is stable.

RECOMMENDATIONS:

- Monitor

UNIT 6 - SPENT FUEL POOL STATUS

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling temporarily lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

- Unit 6 is stable with cooling capacity recovered.

Unit 6 Recommendations:

(b)(4),(b)(5)

Unit 6 Additional Considerations:

(b)(4),(b)(5)

COMMON - SPENT FUEL POOL STATUS

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)

Common SFP Additional Considerations:

- (b)(4),(b)(5)

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

April 25, 2011

[redacted] (b)(4),(b)(5) analysis of the adequacy of the Tokyo Electric Power Company (TEPCO) Roadmap for the purpose of achieving the near term plant stability goals established by the United States Consortium of Industrial and Governmental Organizations*

Introduction: The United States Consortium of Industrial and Governmental Organizations associated with nuclear energy suggests near and long term goals for the stabilization of the damaged Fukushima Daiichi nuclear units. This document is not an official position of the U.S. Nuclear Regulatory Commission or associated industrial or governmental entities. It is meant as technical insights to the Government of Japan on the TEPCO Roadmap. It is understood that the responsibility and decision-making regarding meeting these goals is the responsibility of TEPCO and the Japanese regulatory body.

Purpose: As requested, the purpose of this analysis is to evaluate if the TEPCO Roadmap will accomplish the near term actions necessary to minimize radiological releases and reestablish safety functions. The consortium considers these functions to be reasonable to support long-term efforts that will be needed to achieve a safe end state.

For a description of the TEPCO Roadmap, refer to the last Section of this Assessment.

Background:

Note: For clarity US Consortium items will be non-italicized; *TEPCO items will be italicized.*

The consortium has established five essential functions necessary for achieving the near term goal of establishing plant conditions that provide reasonable confidence that unanticipated conditions will not result in changes to the Protective Action Recommendations for a reasonable period of time. These five essential functions are as follows:

1. Remove decay and chemical heat from reactors, containment, and spent fuel pools.
2. Maintain reactors in cold shutdown and spent fuel pools subcritical and shielded.
3. Ensure structural integrity for all units (e.g. containment and spent fuel pools).
4. Provide reliable indication of essential parameters.
5. Terminate (or render insignificant) uncontrolled radioactive releases.

Factors used to evaluate the status of the essential functions are as follows:

1. Remove decay and chemical heat.

    a. Establish reactor pressure vessel (RPV) water level, reliably maintained, above top of the active fuel (TAF). If unable to maintain RPV water level, establish and maintain containment water levels covering the RPV lower head.
    b. Provide functional and reliable power source equipment for each of the systems being used
    c. Establish a functional and clean water source of sufficient capacity to ensure adequate on-site cooling water needs.
    d. Establish the ability to reliably add makeup to the spent fuel pool.

2. Maintain reactors cold shutdown and spent fuel pools subcritical and shielded.

    e. Establish ability to reliably add makeup to the spent fuel pool to maintain water less than 100 degrees Celcius and level sufficient to enable adequate shielding.
    f. Establish reliable means for boron addition as necessary to maintain sub-criticality in the reactor and in the spent fuel pool, while maintaining awareness of pH and boron solubility limitations.

3. Ensure structural integrity for all units (e.g. containment and spent fuel pools).

    g. Preclude detonation in primary containment atmosphere by establishing a non-combustible atmosphere in the primary containment.
    h. Establish reasonable assurance of SFP integrity.

4. Reliable Indication of essential parameters.

   i. Establish reliable means to determine key parameters associated with actual or potential large releases.
      i. Instrumentation to confirm cold shutdown in reactor vessel and sub-criticality in spent fuel pool,
      ii. Area Radiation, gaseous and liquid release detectors,
      iii. RPV/DW/SP level, RPV/DW pressure indications,
      iv. Primary containment atmosphere sampling system, and
      v. Spent fuel pool level, temperature indications

5. Terminate (or render insignificant) uncontrolled radioactive releases

   j. Establish the means for containment of significant external leakage (e.g. primary containment leakage) for portions of the plant (SFPs or reactor units) with credible potential for energetic releases of significant quantities of radioactive material.
   k. With regard to activities in close proximity to the site, consider measures to minimize further spread of contamination (e.g., covers or resin spray over significant sources of loose contamination at the plant.

Analysis:

The analysis that follows assesses the adequacy of the TEPCO Roadmap countermeasures and risk considerations. It addresses the factors necessary to satisfy the five Consortium identified essential functions necessary to achieve the near term Consortium goal of establishing plant conditions that provide reasonable confidence that unanticipated conditions will not result in changes to the Protective Action Recommendations for a reasonable period of time.

Understandably TEPCO did not include organizational risks and considerations in their Roadmap. The Roadmap is primarily a technical document. Nevertheless, the ~~Consortium~~ NRC has included suggestions regarding organizational issues that, if considered, may enable more efficient and effective implementation of the Roadmap. These organizational issues can also improve the safety of the facility.

Organizational Risks and Considerations:

It is assumed that timelines outlined in the Roadmap are for general coordination of the countermeasures and not a specific schedule of activities. Thus, we suggest that the countermeasures be prioritized so a clearer view of site activities can be gained. Those priorities will guide specific action plans and specific actions as TEPCO progresses through recovery. Countermeasures are often interdependent and will require close coordination. The countermeasures associated with stabilizing the reactors and spent fuel pools should be acted upon first, although many of those countermeasures are dependent upon the successful treatment of radioactive waste.

Other organizational issues associated with the Roadmap are directly related to safety. Those organizational issues are: 1) ensuring a high degree of safety culture and 2) providing independent oversight.

(b)(4),(b)(5)

(b)(4),(b)(5)

Summary of Technical Suggestions:

The following are suggestions to enhance the Roadmap. They are suggestions that, if enacted, could better align the Roadmap to the Consortium's "stability" recommendations.

The Roadmap contains the essential countermeasures for core and spent fuel cooling. Completion of these elements as quickly as possible will reduces the risk of further damages. Obstacles to flooding of the containments, e.g., radwaste processing should be given priority so that containment flooding can begin as quickly as possible.

(b)(4),(b)(5)

The consortium recommends that TEPCO consider adding a redundant source of water as a backup to the normal fuel pool cooling systems for the Unit F2 spent fuel pool. Restoration of the cooling function of fuel pool cooling system would also increase reliability.

The Consortium recommends redundant delivery systems with multiple points of injection to each of the seven fuel locations requiring emergency cooling to improve the reliability of the cooling function. In addition, installing pipes that are seismically supported, in place of fire hoses that are currently being used to carry cooling water will also improve system reliability in case of aftershocks.

The Consortium acknowledges the need to circulate water back to the RPVs to improve the waste-water generation situation. Coupling this action with redundant delivery systems to the fuel locations requiring emergency cooling would be highly beneficial.

The TEPCO Roadmap is silent on maintaining the fuel sub-critical (b)(4),(b)(5)

(b)(4),(b)(5)

The fuel configuration in Units F1, F2, and F3 fuel pools has not been verified. Verification of actual conditions in the spent fuel pools (b)(4),(b)(5) help inform the proposed countermeasures contained in the Roadmap.

(b)(4),(b)(5)

(b)(4),(b)(5)

Factors used to evaluate Essential Function 1 (Remove decay and chemical heat)

a. **Factor: Establish reactor pressure vessel (RPV) water level, reliably maintained, above top of the active fuel (TAF). If unable to maintain RPV water level, establish and maintain containment water levels covering the RPV lower head.**

<u>*(Unit F1 and Unit F3)*</u>

Countermeasure [9]: Flood the primary containment vessel (PCV) up to the top of active fuel (TAF).

Countermeasure [10]: Reduce the amount of radioactive materials (utilization of standby gas treatment system (filter), etc.) when PCV venting (release of steam containing radioactive materials into the atmosphere).

Countermeasure [11]: Continue preventing hydrogen explosion by injecting nitrogen into the PCV.

Risk [4]: Increase in water leakage into the turbine building in the process of flooding the PCV.

Countermeasure [12]: Consideration and implementation of measures to hold down water inflow (e.g., circulating the water back into the RPV by storing and processing the accumulated water in the turbine building.).

Countermeasure [13] Consideration of recovering heat exchange function for the reactor (installing heat exchangers)

Risk [5]: Possibility of prolonged work in high dose level area (keep countermeasures [9] and [12])

<u>(Unit 2)</u>

Countermeasure [14]: Continue cooling by current minimum injection rate.

Countermeasure [16]: Continue consideration and implementation of sealing measure ot damaged location. Implement cooling measures similar to those for Units F1 and F3 once the damaged location is sealed.

Risk [2]: Possibility of prolonged work sealing the damaged location (continue countermeasures [12] and [14]

Factor a. analysis:

(b)(4),(b)(5)

b. Factor: Provide functional and reliable power source equipment for each of the systems being used

Counter measure [8]: Install interconnecting lines of offsite power soon

Countermeasure [22] Continue water injection by "Giraffe", etc (reliability improvement (enhanced durability of hoses)/switch to remote-controlled operation)

Factor b. analysis:

(b)(4),(b)(5)

c. Factor: Establish a functional and clean water source of sufficient capacity to ensure adequate on-site cooling water needs.

Countermeasure [12] Consideration and implementation of measures to hold down water inflow (e.g. circulating water back into the RPV by storing and processing the water in the turbine building)

Countermeasure [23]: Add cooling function to normal fuel pool cooling system and continue injecting water for unit F2.

Countermeasure [24]: Examination for and implementation of restoration of normal cooling system for units F1, F3, and F4.

Factor c. Analysis:

(b)(4),(b)(5) Restoration of the cooling function of fuel pool cooling system would also increase reliability.

The Consortium recommends redundant delivery systems to each of the seven fuel locations requiring emergency cooling.

(b)(4),(b)(5)

The Consortium acknowledges the need to circulate water back to the RPVs to improve the waste-water generation situation. Coupling this action with redundant delivery systems to the fuel locations requiring emergency cooling would be highly beneficial.

d. Factor: Establish the ability to reliably add makeup to the spent fuel pool

Countermeasure [22]: Continue water injection by "Giraffe", etc (reliability improvement (enhanced durability of hoses)/switch to remote-controlled operation.)

Factor d. analysis:

See factor c. analysis.

Factors used to evaluate Essential Function 2 (Maintain reactors shutdown and spent fuel pools subcritical and shielded)

e. **Factor: Establish ability to reliably add makeup to the spent fuel pool to maintain water level sufficient to enable adequate shielding**

   Factor e. analysis:

   See factor c. analysis

f. **Factor: Establish reliable means for boron addition as necessary to maintain sub criticality in the reactor and in the spent fuel pool, while maintaining awareness of pH and boron solubility limitations.**

   Factor f. analysis:

   The TEPCO Roadmap is silent on maintaining the fuel sub-critical and it has not been verified that criticalities have not occurred on any of the units. Criticality events do not appear to be affecting the ability of TEPCO to bring the units and spent fuel to a stable condition.

   The fuel configuration in fuel pools F1, F2, and F3 has not been verified.

   One cooling water sample on the F4 spent fuel pool indicated that criticality had not occurred in the pool. Additional samples would enhance the validity of this single sample. Visual observations indicate that the fuel is intact in the racks.

Factors used to evaluate Essential Function 3 (Ensure structural integrity for all units (e.g. containment and spent fuel pools)

g. **Factor: Preclude detonation in primary containment atmosphere by establishing a non-combustible atmosphere in the primary containment**

Countermeasure [15]: Continue prevention of hydrogen explosion by nitrogen injection into the PCV.

Factor g. analysis

This factor is satisfied for F1.

This factor is not satisfied for F2 and F3.

h. **Factor: Establish reasonable assurance of SFP integrity**

Countermeasure [20]: tolerance evaluation is especially needed for F4. A certain level of seismic tolerance has been confirmed.

Factor h. analysis

The structural concerns related to spent fuel pools are focused on spent fuel pool F4. Spent fuel pool F4 appears to be holding water and the fuel elements are believed to be intact. The structural integrity of reactor buildings F3 and F4 appear to be degraded. Noting that spent fuel pool F4 may have more significant consequences, a similar focus by TEPCO should be placed on the structural integrity of spent fuel pool F3.

Factor used to evaluate Essential Function 4 (Reliable Indication of essential parameters)

i. **Factor: Establish reliable means to determine key parameters associated with actual or potential large releases**
   i. **Instrumentation to confirm cold shutdown in reactor vessel and sub-criticality in spent fuel pool,**

ii. **Area Radiation, gaseous and liquid release detectors,**
iii. **RPV/DW/SP level, RPV/DW pressure indications**
iv. **Primary containment atmosphere sampling system**
v. **Spent fuel pool level, temperature indications**

Countermeasure [57]: Monitoring seawater, soil and atmosphere within the site boundary (25 locations)

Countermeasure [58]: Monitoring the radiation dose at site boundary (12 locations)

Countermeasure [59]: Consideration of monitoring methods in evacuation order / planned evacuation / emergency evacuation preparation areas.

Countermeasure [60] Consideration and implementation of monitoring methods in evacuation order / planned evacuation / emergency evacuation preparation areas (in cooperation with national/prefectural/municipal governments)

Countermeasure [61]: announce accurately monitoring results of long half life residue radioactive materials such as cesium 137

Countermeasure [62]: Monitoring of homecoming residences (in cooperation with national/prefectural/municipal governments)

Countermeasure [63]: Examination and implementation of necessary measures to reduce radiation dose (decontamination of homecoming residences and soil surface) (in cooperation with national/prefectural/municipal governments)

Factor i. analysis

Instrumentation to confirm cold shutdown in the reactor vessels and sub-criticality of spent fuel pools will likely degrade with time. Engaging in investigation and development of alternate instrumentation systems would improve the accuracy of data. Also, the recovery of installed instrumentation should be sought.

Factors used to evaluate Essential Function 5 (Terminate (or render insignificant) uncontrolled radioactive releases)

j. **Establish the means for containment of significant external leakage (e.g. primary containment leakage) for portions of the plant (SFPs or reactor units) with credible potential for energetic releases of significant quantities of radioactive material.**

Countermeasure [29]: identify leakage path and examine and implement preventative measures

Countermeasure [30]: Transferring accumulated water to facilities that can store it (condenser and Centralized Waste Treatment Facility)

Countermeasure [31]: preparing decontamination and desalt of transferred accumulated water

Countermeasure [32]: preparing to install tanks

Countermeasure [33]: Preparing to store with tanks and barges

Countermeasure [34]: Preparing for decontamination and desalt of contaminated water

Countermeasure [35]: Preparing to install reservoir

Countermeasure [36]: Preparing to decontaminate sub-drainage water after being pumped up.

Countermeasure [37]: Utilization of "Centralized Waste Treatment ", to store water

Countermeasure [38]: Install water processing facilities; decontaminate and desalt highly contaminated water and store in tanks.

Risk [7]: Possibility of delay in installing water processing facilities or poor operating performance of the facilities.

Countermeasure [39]: Examination and implementation of backup measures (installment of additional tanks or pools or leakage prevention by coagulator, etc)

Countermeasure [40]: Increase storage capacity by adding tanks , barges, Megafloat, etc.

Countermeasure [41]: Decontaminating contaminated water using decontaminates to below acceptable criteria

Countermeasure [42]: Expansion of additional tanks to store high radiation level contaminated water

Countermeasure [43]: Continuation and reinforcement of decontamination and desalt of high radiation level water

Countermeasure [44]: Continuation and reinforcement of decontamination and desalt of low radiation level water.

Countermeasure [45]: Reuse of processed water as reactor coolant.

Countermeasure [46]: Decontamination to the level below criteria level.

Factor j. analysis:

When put in place these water management countermeasures should satisfy this factor.

k. Factor: With regard to activities in close proximity to the site, consider measures to minimize further spread of contamination (e.g., covers or resin spray over significant sources of loose contamination at the plant)

Countermeasure [47]: Inhibit scattering of radioactive materials by full-scale dispersion inhibitor after confirming its performance by test.

Countermeasure [48]: Prevent rainwater contamination by dispersion inhibitor

Countermeasure [49]: Removal of debris

Countermeasure [50]: Examination and implementation of basic design for reactor building cover full fledged measure (container with concrete roof and wall, etc.)

Countermeasure [51]: Consideration of solidification, substitution and cleansing of contaminated soil (mid-term issues)

Countermeasure [52]: Improvement of work condition by expanding application and dispersion of inhibitors to the ground and buildings.

Countermeasure [53]: Continue removal of debris.

Countermeasure [54]: Begin installing reactor building cover (with ventilation and filter)

Risk [8]: Considerable reduction in radiation dose is a prerequisite to launch construction.

Countermeasure [55]: Complete installing reactor building covers (Units 1, 3, and 4)

Countermeasure [56]: Begin detailed design of full-fledged measure (container with concrete roof and wall, etc.)

Factor k. analysis:

Give consideration of completely isolating the site from the Ocean by erecting underground barriers or the installation of wells to pump out groundwater. When completed these countermeasures could be effective in satisfying the factor.

* The United States Consortium of Industrial and Governmental Organizations was established to provide advice and assistance to the people of Japan in an effort to stabilize and improve conditions at the Fukushima Daiichi Reactor Site following the earthquake and tsunami on March 11, 2011. The Consortium includes:

General Electric Hitachi
Institute of Nuclear Power Operations
Naval Reactors
Knolls Atomic Power Laboratory
Bettis Atomic Power Laboratory
US Department of Energy/Nuclear Energy
United States Nuclear Regulatory Commission

ROADMAP DESCRIPTION

On April 17,2011 TEPCO publically announced, "With regard to the accident at FUKUshima Daiichi Nuclear Power Station due to the Tohokku-Chihou-Taiheiyo-Oki Earthquake [which] occurred on Friday March11th, 2011, we are currently making our utmost effort to bring the situation under control. This announcement is to notify [the public of] the roadmap that we have put together towards restoration of the accident."

The TEPCO Roadmap basic policy is to bring the reactors and spent fuel pools to a stable cooling condition and mitigate the release of radioactive materials making every effort to enable evacuees to return to their homes and for all citizens to be able to secure a sound life.

The TEPCO Roadmap has two target steps:

Step 1: *Radiation dose is in steady decline (around 3 months)*

Step 2: *Release of radioactive material is under control and radiation dose is being significantly held down (3 to 6 months after achieving step1)*

In order to meet the target steps, TEPCO has established 3 areas with 5 issues organized as follows:

1. *Cooling*

(1) Cooling the reactors

(2) Cooling the spent fuel pools

2. *Mitigation*

(3) Containment, Storage, Processing, and reuse of water contaminated by Radioactive Materials (Accumulated Water)

(4) Mitigation of Release of Radioactive Materials to Atmosphere and from Soil

3. *Monitoring /Decontamination*

(5) Measurement, Reduction, and Announcement of Radiation Dose in Evacuation Order/Planned Evacuation /Emergency Evacuation Preparation Areas

TEPCO has developed twelve Step 1 and Step 2 targets as immediate actions to address the five issues as follows:

(1) Cooling the reactors

1) Maintain stable cooling (step 1)

2) (Unit 2) Cool the reactor while controlling the increase of accumulated water until the PCV is sealed (step 1)

3) Achieve cold shutdown condition (sufficient cooling is achieved depending on the status of each unit) (step 2)

(2) Cooling the Spent Fuel Pools

4) Maintain stable cooling (step 1)

5) Maintain more stable cooling function by keeping a certain level of water (step 2)

(3) Containment, Storage, Processing, and Reuse of Water Contaminated by radioactive Materials (Accumulated Water)

6) *Secure sufficient storage place to prevent water with high radiation level from being released out of the boundary. (step 1)*
7) *Store and Process water with low radiation level (step 1)*
8) *Decrease the total amount of contaminated water (step 2)*

(4) Mitigation of Release of Radioactive Materials to Atmosphere and from Soil

9) *Prevent scattering of radioactive materials on buildings and ground (step 1)*
10) *Cover the entire buildings (as a temporary measure) (step 2)*

(5) Measurement, Reduction, and Announcement of Radiation Dose in Evacuation Order/Planned Evacuation /Emergency Evacuation Preparation Areas

11) *Expand/enhance monitoring and inform of results fast and accurately (step 1)*
12) *Sufficiently reduce radiation dose in evacuation order/planned evacuation/emergency evacuation preparation areas*

TEPCO has developed 63 countermeasures and 9 risk considerations to implement the twelve step 1 and step 2 targets.

From: RST01 Hoc
Sent: Thursday, March 24, 2011 10:25 PM
To: RST01 Hoc; RST02 Hoc; mossdj@inpo.org; Casto, Chuck; Nakanishi, Tony; Monninger, John; Devercelly, Richard; Foster, Jack; Trapp, James
Cc: RST03 Hoc; INPOERCAssistance; Ruland, William; Versluis, Rob
Subject: Reactor Safety Team Assessment 2000 EDT 3-24-2011
Attachments: 03-24-11 2000 RST Assessment Document.docx

All,

The reactor safety team has compiled its assessment report of conditions and recommendations at the damaged Fukushima Daiichi reactor plants.

Shortly after our completion of the attached report, the RST received a new update from JAIF with a time-date stamp of 2200 JDT 3/24/2011 (0900 EDT 3/24/2011), that indicates changes in their view of containment integrity in units One and Three, indicating the containment vessel integrity status as "Not Damaged". This information has not been factored into the assessment report, and the RST will be moving forward to review and evaluate this latest status report.

We request that our INPO addressee please forward this assessment to the EPRI staff who are involved in this event response activity.

If you have any comments or questions on this report, please contact the Reactor Safety Team at RST01.Hoc@nrc.gov.

John Thorp
RST Chronologist Evening Shift, 3/24/2011

March 25, 2011 0600 EDT

Briefing Sheet
Fukushima Daiichi

Plant status remains unchanged from status at 1515.

PMT is working with OSTP and EPA to properly manage and communicate all environmental data collected domestically, including iodine in drinking water. PMT briefed that the detected iodine levels in the rain water are substantially below the drinking water standards. RADnet is posting current monitoring data on web. This info is being integrated with data gathered from test band monitoring and reported to OSTP.

DOE has agreed the US should reach out to Japan as one voice only. To facilitate this, DOE (Pete Lyons and Steve Aoki) were provided a summary of the 1000 industry consortium call. In addition, NRC/RES will participate in a DOE call everyday from 1700 to 1800. This will help facilitate the one voice. Chairman is continuing to work with others to establish a Senior level person as a focal point.

Per NRC Japan team, Japan has officially accepted the pumping system at the air force base, and will be using it. Will move equipment tomorrow afternoon after receiving training on it at base. Japan also accepted and plans are being made for the U.S. Navy to provide two water barges as well. No delivery date yet, worried about possible harbor damage from earthquake. The NRC team also reports that they have accepted 5 seats within the TEPCO EOC. Will show up there first time Friday morning (JST) with INPO representative.

INPO/DOE has accepted action to figure out how to remove spent fuel from the site. The Japanese provided a list of the things they would accept, including the million doses of KI, bottled water, rad. monitoring equipment, robotics and remote control equipment. DOD and DOE lead. There will be an actual list with parties identified developed 25 March.

The NRC Reactor Safety Team has provided a set of recommendations pertaining to severe accident management strategies to the NRC team in Japan. The recommendations were coordinated with GEH, EPRI, INPO, Naval Reactors and DOE.

The NRC Protective Measures Team developed guidance, at the request of State Dept., to be provided to Americans such that they could temporarily re-enter the 50-mile evacuation zone (not to enter the Japanese 20 Km evacuation zone) for the purposes of retrieving personal effects. Guidance will soon be finalized and be provided to the NRC Japan team to get to the Ambassador.

The Liaison Team is nearing completion of assembling briefing information to support the Chairman's meeting with the Japanese Ambassador at 11:00 a.m. this morning. The team has developed information, coordinating with the NRC Site Team in Japan, specifically related to effectiveness of coordination.

MEMORANDUM TO: Chairman Jaczko

FROM: Margaret M. Doane, Director
Office of International Programs

SUBJECT: (b)(5)

(b)(5)

From: Jaczko, Gregory <Gregory.Jaczko@nrc.gov>
Sent: Thursday, March 24, 2011 11:45 PM
To: Coggins, Angela; Batkin, Joshua; Pace, Patti
Subject: FW: Remote Support Made Easy

From: GoToAssist Express[SMTP:GTAE@OMNI-CHANNEL-BASE.COM]
Sent: Thursday, March 24, 2011 11:44:38 PM
To: Jaczko, Gregory
Subject: Remote Support Made Easy
Auto forwarded by a Rule

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RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2), Based on most recent available data and input from industry and government sources

(b)(4),(b)(5)

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.

<u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

<u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assumptions: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – 0.416, steady (60.3 psig)

B – 0.908, rising (131.7 psig).

RPV Temperature (°C)

Bottom Head – 119, steady (246.2°F)

Feedwater Nozzle – 216.2 and lowering (421.2°F)

PCV Pressure (MPaa)

DW – 0.19 (27.6 psia)

SC – 0.165 (23.9 psia) rising.

DW CAMS (Sv/hr) – INOP

S/C CAMS (Sv/hr) – 10.8 (1080 rem/hr) lowering

Containment Atmosphere – Inert, Nitrogen injection in progress

Other Information:

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power has been restored to the Main Control Room Panels (3/29/11 TEPCO).

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5) Recirculation pump seals have likely failed (GEH).

Core Status: (b)(4),(b)(5)

(b)(4),(b)(5) the volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

RPV Structural Integrity: Unknown

Assessment:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt. Core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but providing limited if any flow past the fuel. It is difficult to determine how much cooling is getting to the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Secondary Containment: Severely damaged (hydrogen explosion). (b)(5) (b)(5) shows entire fuel floor covered by grey-brown debris of building roof.

(b)(4),(b)(5)

Rad levels outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

➢ (b)(4),(b)(5)

➢

➢ Inject into the RPV with all available resources (b)(4),(b)(5)

(b)(4),(b)(5)

➢ Vent containment (b)(4),(b)(5)

(b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)

a. To maintain containment pressure below the primary containment pressure limit.
b. As necessary to maintain RPV injection above MDRIR.
c.
d. (b)(4),(b)(5)

➢ (b)(4),(b)(5)

➢

➢ Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The short-term goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations B.1. through C.5 below).

(b)(4),(b)(5)

(b)(4),(b)(5)

Additional Considerations:

A. The following considerations apply to containment venting:

1.

2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect

(b)(4),(b)(5)

5.

B. Additional Miscellaneous considerations

1.

(b)(4),(b)(5)

2.

3. Ensure spent fuel pool level is maintained as full as possible.

4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel (b)(4),(b)(5)

5. (b)(4),(b)(5)

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)
4.
5.

Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.07 MWth (b)(6) evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. (b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 SFP Recommendations:

(b)(4),(b)(5)

Unit 1 SFP Additional Considerations:

(b)(4),(b)(5)

– (b)(4),(b)(5)

UNIT TWO CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assumptions: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – (-.023), steady (-3.3 psig)

B – (-0.025), steady (-3.6 psig)

RPV Temperature (°C)

Bottom Head – 208.1, steady (406°F)

Feedwater Nozzle – 165.8 and lowering (330°F)

PCV Pressure (MPaa)

DW – 0.09 (13.1 psia)

SC – unknown

DW CAMS (Sv/hr) – 28.1 (2810 rem/hr)

S/C CAMS (Sv/hr) – .68 (68 rem/hr)

Containment Atmosphere – Unknown, nitrogen injection scheduled to begin 4/20/11

Other Information: External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5) Recirculation pump seals have likely failed (GEH).

(b)(4),(b)(5)

RPV Structural Integrity: Unknown

Assessment:
Damaged fuel may have slumped with the majority located on the core plate. Fuel in the lower region of the core is likely encased in salt, though the lower temperatures reported indicate that the amount of salt build-up is likely less than in Unit 1. (b)(4),(b)(5)

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. (b)(4),(b)(5) Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height, though (b)(4),(b)(5) Natural circulation believed impeded by core damage. (b)(4),(b)(5) (b)(4),(b)(5) Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

(b)(4),(b)(5)

Primary Containment: Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

(b)(4),(b)(5)

Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5)
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available

(b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.5. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)
  d.

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The short-term goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations B.4. through C.5 below)

(b)(4),(b)(5)

(b)(4),(b)(5)

Additional Considerations

A. The following considerations apply to containment venting:

1.

2.

3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.

4. (b)(4),(b)(5)

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps

2. Radiation monitoring instruments (b)(4),(b)(5)

3. (b)(4),(b)(5)

4.

5.

UNIT 2 - SPENT FUEL POOL STATUS

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.5 MWth; (b)(6) evaporation rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11
Fuel Pool Water Temperature:	46°C (TEPCO 4/12)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)
-
-
-

Unit 2 Additional Considerations:

- (b)(4),(b)(5)
-

UNIT THREE CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assessment: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – (-.019), steady (-2.8 psig)

B – (-0.079), steady (-11.5 psig)

RPV Temperature (°C)

Bottom Head – 105, steady (222°F)

Feedwater Nozzle – 105.4 and lowering (221.7°F)

PCV Pressure (MPaa)

DW – 0.105 (15.3 psia)

SC – .1692 (24.5 psia)

DW CAMS (Sv/hr) – 17.4 (1740 rem/hr)

S/C CAMS (Sv/hr) – .67 (67 rem/hr)

Containment Atmosphere – Unknown

Other Information: On offsite AC power (NISA 4/3).

(b)(4),(b)(5)

(b)(4),(b)(5)

RPV Structural Integrity: Unknown

Assessment:
Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, though the lower reported temperatures indicate that the amount of salt build-up is likely less than in Unit 1. Nonetheless, core flow capability is in jeopardy due to the salt build up (b)(4),(b)(5)

Water injection is to the RPV is occurring through the RHR system via the recirculation piping, but with limited flow past the fuel. (b)(4),(b)(5) (b)(4),(b)(5) Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height, though core flow capability may be affected due to continued salt build up. Natural circulation is believed to be impeded by core damage. (b)(4),(b)(5) (b)(4),(b)(5) Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Secondary Containment: Damaged (JAIF, NISA, TEPCO). (b)(4),(b)(5) (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5)
  (b)(4),(b)(5)
  a. core spray (b)(4),(b)(5)
  (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available

-
-
-

(b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.5. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)
  d.

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The short-term goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations B.4. through C.5. below).

(b)(4),(b)(5)

Additional Considerations:

A. The following considerations apply to containment venting:

1.

2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. (b)(4),(b)(5)

2. Ensure spent fuel pool level is maintained as full as possible.

3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.

4. (b)(4),(b)(5)

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps

2. Radiation monitoring instruments (b)(4),(b)(5)

3.

4. (b)(4),(b)(5)

5.

UNIT 3 - SPENT FUEL POOL STATUS

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2010)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm. 80 tons added on 4/10.
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	External AC power has reached the unit

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

(b)(4),(b)(5)

Unit 3 Additional Considerations:

(b)(4),(b)(5)

– (b)(4),(b)(5)

UNIT FOUR CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Core Status: Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)

Core Cooling: Not necessary (JAIF, NISA, TEPCO)

Primary Containment: Not applicable (JAIF, NISA, TEPCO)

Secondary Containment: Severely damaged in hydrogen explosion. (JAIF, NISA, TEPCO)

Rad Levels: No information

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO).

UNIT 4 - SPENT FUEL POOL STATUS

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	2.3 MWth (b)(6) evaporation rate 20,000 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm (38 tons of water added on 4/7/11)
Fuel Pool Water Temperature:	30°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

(b)(4),(b)(5)

Unit 4 Recommendations:

-
-
- (b)(4),(b)(5)
-
-

Unit 4 Additional Considerations:

- (b)(4),(b)(5)
-

UNIT FIVE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

RPV: Pressure .4 psig (NISA 4/8); Temp: 45.5°C (NISA 4/8)

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5)

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment: Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool: 946 bundles (JAIF); Temp: 34.7oC↓ (JAIF 4/8)
Cooling capability recovered and functioning (JAIF 4/1)

Other: On offsite AC power (b)(6) 3/28).

ASSESSMENT:

Unit five is stable.

RECOMMENDATIONS:

- Monitor

UNIT 5 - SPENT FUEL POOL STATUS

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling temporarily lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

- Unit 5 is stable with cooling capacity recovered.

Unit 5 Recommendations:

➢ (b)(4),(b)(5)
➢
➢

Unit 5 Additional Considerations:

- (b)(4),(b)(5)
-

UNIT SIX CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

RPV: Pressure .7 psig (NISA 4/8); Temp: 22.7°C (NISA 4/8)

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5)

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment: Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool: 876 bundles (b)(6)
Temp: 30.5.0°C (NISA 4/8)
Cooling capability recovered and functioning (JAIF 4/1).

Other: On offsite AC power (b)(6) 3/28)

ASSESSMENT:

Unit Six is stable.

RECOMMENDATIONS:

- Monitor

UNIT 6 - SPENT FUEL POOL STATUS

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling temporarily lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

- Unit 6 is stable with cooling capacity recovered.

Unit 6 Recommendations:

- (b)(4),(b)(5)

Unit 6 Additional Considerations:

- (b)(4),(b)(5)

COMMON - SPENT FUEL POOL STATUS

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)
-

Common SFP Additional Considerations:

- (b)(4),(b)(5)
-

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2), Based on most recent available data and input from GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

(b)(4),(b)(5)

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.

<u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

<u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assumptions: (As of 0700, 4/12/11)

RPV Pressure (Mpag)

A – 0.416, steady (60.3 psig)

B – 0.908, rising (131.7 psig)

RPV Temperature (°C)

Bottom Head – 119, steady (246.2°F)

Feedwater Nozzle – 216.2 and lowering (421.2°F)

PCV Pressure (MPaa)

DW – 0.19 (27.6 psia)

SC – 0.165 (23.9 psia) rising

DW CAMS (Sv/hr) – INOP

S/C CAMS (Sv/hr) – 10.8 (1080 rem/hr) lowering

Containment Atmosphere – Inert, Nitrogen injection in progress

Other Information:

On offsite AC power – Control Room lighting for U-1, 2, 3, & 4 (JAIF, 4/1)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Reactor water level (b)(4),(b)(5)
(b)(4),(b)(5) Recirculation pump seals have likely failed (GEH).

Core Status: (b)(4),(b)(5)
(b)(4),(b)(5) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

(b)(4),(b)(5)

Assessment:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

(b)(4),(b)(5)

Primary Containment: Damage suspected (b)(4),(b)(5)

(b)(4),(b)(5)

Secondary Containment: Severely damaged (hydrogen explosion). (b)(5) (b)(5) shows entire fuel floor covered by grey-brown debris of building roof.

(b)(4),(b)(5)

(b)(4),(b)(5)

Rad levels outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)
(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5)

- Vent containment (b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.

(b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations B~~C~~.1. through C.~~4~~5 below).

(b)(4),(b)(5)

(b)(4),(b)(5)

Additional Considerations

A. The following considerations apply to containment venting:

1.

2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect and

(b)(4),(b)(5)

5.

B. Additional Miscellaneous considerations

1.

(b)(4),(b)(5)

2.

3. Ensure spent fuel pool level is maintained as full as possible.
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5)
5. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) uction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3. (b)(4),(b)(5)
4.
5.

UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel: 292 bundles

Last transfer from Reactor: 64 bundles (March 29 to April 2, 2010)

Decay Heat [megawatt thermal (MWth)]: 0.07 MWth (b)(6) evaporation rate 780 gallons per day

Fuel Pool Structural Support Integrity: (b)(4),(b)(5)

Fuel Pool Leak Integrity: No data

Criticality status: No data

Fuel Pool Level: No data

Water Injection Method and Source: Periodic fresh water injected via a hose off of a concrete pumper truck arm

Fuel Pool Water Temperature: 18°C (3/31 0815)

Power Status: Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. (b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 SFP Recommendations:

- (b)(4),(b)(5)
-
-
-

Unit 1 SFP Additional Considerations:

- (b)(4),(b)(5)
-

UNIT TWO CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assumptions: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – (-.023), steady (-3.3 psig)

B – (-0.025), steady (-3.6 psig)

RPV Temperature (°C)

Bottom Head – 208.1, steady (406°F)

Feedwater Nozzle – 165.8 and lowering (330°F)

PCV Pressure (MPaa)

DW – 0.09 (13.1 psia)

SC – unknown

DW CAMS (Sv/hr) – 28.1 (2810 rem/hr)

S/C CAMS (Sv/hr) – .68 (68 rem/hr)

Containment Atmosphere – Unknown, nitrogen injection scheduled to begin 4/20/11

Other Information:

External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(5)

Assessment:

Damaged fuel may have slumped with the majority located on the core plate and fuel in the lower region of the core is likely encased in salt. However, the amount of salt build-up appears to be less than U-1 based on the reported lower temperatures. (b)(4),(b)(5) Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling flow is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

(b)(5)

(b)(4),(b)(5)

Primary Containment: Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

RECOMMENDATIONS: (for Unit 2)

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available

(b)(4),(b)(5)

(b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.5. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c.
  d. (b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations ~~C.1~~B.4. through C.~~4~~5 below)

(b)(4),(b)(5)

Additional Considerations

A. The following considerations apply to containment venting:

1.

2. (b)(4),(b)(5)

3.

(b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5)
(b)(4),(b)(5)
~~C.~~
~~a.~~1 (b)(4),(b)(5) HPCI (b)(4),(b)(5) uction pressure and Drywell instrument taps.
~~b.~~2. Radiation monitoring instruments (b)(4),(b)(5)
~~c.~~3
~~d.~~4 (b)(4),(b)(5)
~~e.~~5

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UNIT 2 - SPENT FUEL POOL STATUS

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.5 MWth; (b)(6) evaporation rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) ~~4/3)~~
Water Injection Method and Source:	Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11
Fuel Pool Water Temperature:	46°C (TEPCO 4/12)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

– (b)(4),(b)(5)

–

–

–

Unit 2 Additional Considerations:

– (b)(4),(b)(5)

–

UNIT THREE CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Control Parameter Assessment: (As of 0700, 4/12/11)

RPV Pressure (MPag)

A – (-.019), steady (-2.8 psig)

B – (-0.079), steady (-11.5 psig)

RPV Temperature (°C)

Bottom Head – 105, steady (222°F)

Feedwater Nozzle – 105.4 and lowering (221.7°F)

PCV Pressure (MPaa)

DW – 0.105 (15.3 psia)

SC – .1692 (24.5 psia)

DW CAMS (Sv/hr) – 17.4 (1740 rem/hr)

S/C CAMS (Sv/hr) – .67 (67 rem/hr)

Containment Atmosphere – Unknown

Other Information:

On offsite AC power (NISA 4/3).

(b)(4),(b)(5)

(b)(4),(b)(5)

Core Status: (b)(4),(b)(5)

RPV Structural Integrity: Unknown

(b)(4),(b)(5)

Assessment:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Water injection is to the RPV through the RHR system via the recirculation piping, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. (b)(4),(b)(5) (b)(4),(b)(5) Vessel temperature readings are likely metal temperature which lags actual conditions. (b)(4),(b)(5) (b)(4), (b)(5)

(b)(5)

(b)(4),(b)(5)

(b)(5)

(b)(5)

(b)(4),(b)(5)

Primary Containment: Damage suspected (RST, NISA, TEPCO) "Not damaged" (JAIF).

(b)(4),(b)(5)

Secondary Containment: Damaged (JAIF, NISA, TEPCO) (b)(4),(b)(5) (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5):
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
  d. (b)(4),(b)(5)

- (b)(4),(b)(5)
-

➢ (b)(4),(b)(5)

➢ Vent containment: (see Additional Considerations A.1. through A.5. below)
   a. To maintain containment pressure below the primary containment pressure limit.
   b. As necessary to maintain RPV injection above MDRIR.
   c. (b)(4),(b)(5)
   d.

➢ Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations ~~C.1~~B.4. through C.~~3~~5. below)

(b)(4),(b)(5)

Additional Considerations

A. The following considerations apply to containment venting:

   1. (b)(4) (b)(5)

   2.

3. (b)(4),(b)(5)

4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. (b)(4),(b)(5)
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5)

~~C.~~

~~a.~~1. (b)(4),(b)(5) HPC (b)(4),(b)(5) uction pressure and Drywell instrument taps

~~b.~~2. Radiation monitoring instruments (b)(4),(b)(5)

~~c.~~3. (b)(4),(b)(5)

4.

~~d.~~5.

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UNIT 3 - SPENT FUEL POOL STATUS

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, ~~2011~~2010)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) ~~4/3)~~
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm. 80 tons added on 4/10.
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

- (b)(4),(b)(5)
-
-
-

Unit 3 Additional Considerations:

- (b)(4),(b)(5)
-

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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UNIT FOUR CORE

ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)

Core Status: Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)

Core Cooling: Not necessary (JAIF, NISA, TEPCO)

Primary Containment: Not applicable (JAIF, NISA, TEPCO)

Secondary Containment: Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO). (b)(4),(b)(5)

(b)(4),(b)(5)

(b)(5)

UNIT 4 - SPENT FUEL POOL STATUS

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	2.3 MWth (b)(6) evaporation rate 20,000 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm (38 tons of water added on 4/7/11)
Fuel Pool Water Temperature:	30°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

- (b)(4),(b)(5)

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(b)(4),(b)(5)

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Unit 4 Additional Considerations:

(b)(4),(b)(5)

(b)(4),(b)(5)

UNIT FIVE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .4 psig↔ (NISA 4/8) ; Temp: 45.5°C↑ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) 3/31);

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
946 bundles (b)(6) Temp: 34.7oC↓ (JAIF 4/8) (b)(4),(b)(5)

Other: On offsite AC power (b)(6) 3/28). External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Unit five is ~~relatively~~ stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

UNIT 5 - SPENT FUEL POOL STATUS

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

- Unit 5 is stable with cooling capacity recovered.

Unit 5 Recommendations:

-
- (b)(4),(b)(5)
-

Unit 5 Additional Considerations:

-
- (b)(4),(b)(5)

(b)(4),(b)(5)

UNIT SIX CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .7 psig↔ (NISA 4/8) ; Temp: 22.7°C↔ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); Cooling using RHR; injection via normal make-up water (IAEA 3/31);

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
876 bundles (b)(6) Temp: 30.5.0°C↑ (NISA 4/8); (b)(4),(b)(5)
(b)(4),(b)(5)

Other: On offsite AC power (IAEA 3/28); (b)(4),(b)(5)

ASSESSMENT:

Unit Six is ~~relatively~~ stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

UNIT 6 - SPENT FUEL POOL STATUS

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	(b)(4),(b)(5)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

- Unit 6 is stable with cooling capacity recovered.

Unit 6 Recommendations:

-
-
-

(b)(4),(b)(5)

Unit 6 Additional Considerations:

-
-

(b)(4),(b)(5)

(b)(4),(b)(5)

COMMON - SPENT FUEL POOL STATUS

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)
-

Common Additional Considerations:

- (b)(4),(b)(5)
-

REFERENCES

1. EPRI recommendations March 18, 2011 (b)(5)
2. SFP Criticality Potential, Kent Wood, March 24, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. EPRI recommendations March 18, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 24, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(b)(4)	1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

(b)(4),(b)(5)

1000 April 9, 2011

Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

(b)(4),(b)(5)

**RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2),
Based on most recent available data and input from GEH, EPRI,
Naval Reactors (with Bettis and KAPL), and DOE/NE**

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate at which it is expected that core debris will be retained in the RPV when RPV water level cannot be determined to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is sufficient to remove decay heat from core debris.

<u>Minimum Debris Submergence Level (MDSL)</u> is the lowest primary containment water level at which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

<u>Minimum Drywell Spray Flow (MDSF)</u> is the lowest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function. The MDSF is typically in thousands of gallons per minute.

UNIT ONE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

(b)(4),(b)(5) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate. (GEH, INPO, Bettis, KAPL).

Vessel temperatures and pressures:

119 °C at bottom head (increasing) and 246 °C at FW nozzle (steady) (NISA 4/8) (TEPCO 0700 JDT 3/30). RPV channel A=57.3 psig, channel B=115.0 psig both increasing (NISA 4/8), DW and torus pressure at 35 psia (decreasing trend) (TEPCO 0700 JDT 3/30). (This will change daily, along with injection rates, etc- For all units)

Core Cooling: Currently fresh water injection with no boron, injecting through feedwater line at 100 l/min (26.4 gpm) and steady(TEPCO 4/7). (b)(4),(b)(5)
(b)(4),(b)(5)
(TEPCO); Injection flow rate will be maintained above the MDRIR. Recirculation pump seals have likely failed. (GEH); Injection flow rate above MDRIR could not be maintained through core spray. (b)(4),(b)(5)
(b)(4),(b)(5)

RPV -
Structural Integrity: Unknown

Primary Containment:
Damage suspected, (b)(4),(b)(5)

Dry Well: Dry well pressure 12.1 psig and increasing (NISA 4/8). Torus press. 7.8 psig and increasing (NISA 4/8). (b)(4),(b)(5)

Secondary Containment:
Severely damaged (hydrogen explosion).

Rad levels: DryWell 6830 rem/hr and decreasing (NISA 4/8, INPO attributes this to a failed instrument), Torus 1220 rem/hr and steady (NISA 4/8), Outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: On offsite AC power – Control Room lighting for U-1, 2, 3, & 4 (JAIF, 4/1)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. (b)(4),(b)(5)

(b)(4),(b)(5)

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GEH believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core shroud. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(5) shows entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- (b)(4),(b)(5)
- Vent containment (b)(4),(b)(5) (b)(4),(b)(5) (See Additional Considerations A.1. through A.5 below)
    a. To maintain containment pressure below the primary containment pressure limit.
    b. As necessary to maintain RPV injection above MDRIR.
    c. (b)(4),(b)(5)
    d.

(b)(4),(b)(5)

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

Additional Considerations

A. The following considerations apply to containment venting:

1.
2.

(b)(4),(b)(5)

3.

4. Spray water on steam plumes and planned containment vents for scrubbing effect and

(b)(4),(b)(5)

5.

B. Additional Miscellaneous considerations

1. (b)(4),(b)(5)

2. (b)(4),(b)(5)
3. Ensure spent fuel pool level is maintained as full as possible.
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4),(b)(5) (b)(4),(b)(5)
5. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level:

1. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
2. Radiation monitoring instruments (b)(4),(b)(5)
3.
4. (b)(4),(b)(5)
5.

UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Water Temperature:	18°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting.

(b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

- ➢
- ➢ (b)(4),(b)(5)
- ➢
- ➢

Unit 1 Additional Considerations:

- – (b)(4),(b)(5)
- –

(b)(4),(b)(5)

UNIT TWO CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

Vessel temperature and pressures: RPV pres: (ch A= -2.9 psig and decreasing , ch B= -2.9 psig and decreasing) (NISA 4/8); RPV temp: Btm Head (not avail) (TEPCo), FW nozzle 141.2°C↓ (NISA 4/8),

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) (b)(4),(b)(5) (b)(4),(b)(5) Bottom head temperature 131.6 C, feed water nozzle temperature 172.4 C (TECPO 0700 3/30/11)) Recirculation pump seals have likely failed. (Industry)

Reactor Pressure Vessel structural Integrity – Unknown

Primary Containment:

Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

Drywell pressure reading -0.2 psig↔ (NISA 4/8)

Secondary Containment:

(b)(4),(b)(5)
(b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News)

Rad Levels: Drywell 2940 rem/hr↓ (NISA 4/8); Torus 77 rem/hr↔ (NISA 4/8)

Outside plant: 11 mR/hr at gate (variable) (TEPCO 0700 JDT 3/30)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped with the majority located on the core plate and fuel in the lower region of the core is likely encased in salt. However, the amount of salt build-up appears to be less than U-1 based on the reported lower temperatures. (b)(4),(b)(5) Core flow capability is in jeopardy due to continued salt build up.

Injecting water through the low pressure core injection line is cooling the vessel, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling flow is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up (b)(5) but is adequately cooled.

The primary containment is damaged

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5) (b)(4),(b)(5)
  a. core spray (b)(4),(b)(5) (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available
- (b)(4),(b)(5)
-

- (b)(4),(b)(5)

- Vent containment: (see Additional Considerations A.1. through A.5. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)
  d.

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.4 below)

Additional Considerations

A. The following considerations apply to containment venting:

1. (b)(4),(b)(5)
2.
3.
4. Spray water on steam plumes and planned containment vents for scrubbing effect.

5. (b)(4),(b)(5)

B. Additional Miscellaneous considerations

1. Borate water if possible.
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. Monitor the following for (b)(4),(b)(5)

a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps
b. Radiation monitoring instruments (b)(4),(b)(5)
c. (b)(4),(b)(5)
d.
e.

UNIT 2 - SPENT FUEL POOL STATUS

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)

Unit 2 Additional Considerations:

- (b)(4),(b)(5)

(b)(4),(b)(5)

UNIT THREE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5)

Vessel temperature and pressure: RPV pressure: ch A= -.6 psig↓ , ch B= -11.4 psig) ↔ (NISA 4/8); RPV temp: Btm Head 110.8°C↔ ; FW nozzle: 88.8°C↔ (NISA 4/8)

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) (b)(4),(b)(5) (b)(4),(b)(5) Recirculation pump seals have likely failed.

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

Damage suspected (RST, NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)

Drywell pressure 0.6 psig↔ (NISA 4/8), Torus pressure 10.3 psig↔ (NISA 4/8)

Secondary Containment

Damaged (JAIF, NISA, TEPCO). Severe damage from H_2 explosion. May begin to inject nitrogen gas (NHK World News)

Spent Fuel Pool

(b)(4),(b)(5)

Rad Levels: DW 1880 rem/hr ↔ (NISA 4/8), torus 73.8 rem/hr↔ (NISA 4/8)

Outside plant: 11 mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: On offsite AC power (NISA 4/3). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Water injection is to the RPV through the RHR system via the recirculation piping, but with limited flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release.

There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement has flooded. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS:

The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

- Inject into the RPV with all available resources (b)(4),(b)(5)
  (b)(4),(b)(5)
  a. core spray (b)(4),(b)(5)
     (b)(4),(b)(5)
  b. feedwater system
  c. other systems as they become available

- (b)(4),(b)(5)
-
-

- Vent containment: (see Additional Considerations A.1. through A.8. below)
  a. To maintain containment pressure below the primary containment pressure limit.
  b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)
  d.

- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations C.1. through C.3. below)

Additional Considerations

A. The following considerations apply to containment venting:

1. (b)(4),(b)(5)
2.
3.
4. Spray water on steam plumes and planned containment vents for scrubbing effect.
5. (b)(4),(b)(5)

B. Additional Miscellaneous consideration

1. (b)(4),(b)(5)
2. Ensure spent fuel pool level is maintained as full as possible.
3. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel.
4. When flooding containment, consider the implications of water weight on seismic capability of containment.

C. Potential methods for monitoring containment level. Monitor the following for (b)(4),(b)(5)

a. (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure and Drywell instrument taps

b. Radiation monitoring instruments (b)(4),(b)(5)

c. (b)(4),(b)(5)

d.

UNIT 3 - SPENT FUEL POOL STATUS

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm. 80 tons added on 4/10.
Fuel Pool Water Temperature:	57°C (JAIF 4/6)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

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(b)(4),(b)(5)

Unit 3 Additional Considerations:

–

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(b)(4),(b)(5)

(b)(4),(b)(5)

UNIT FOUR CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)

Core Cooling: Not necessary (JAIF, NISA, TEPCO)

Primary Containment: Not applicable (JAIF, NISA, TEPCO)

Secondary Containment: Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)

Rad Levels:

No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

1. Maintain coverage of spent fuel pool with fresh water. (b)(4),(b)(5)
   (b)(4),(b)(5)
2. As possible, put spent fuel cooling and cleanup in service.

UNIT 4 - SPENT FUEL POOL STATUS

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm (38 tons of water added on 4/7/11)
Fuel Pool Water Temperature:	30°C (JAIF 4/4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

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(b)(4),(b)(5)

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–

Unit 4 Additional Considerations:

-
(b)(4),(b)(5)
-

(b)(4),(b)(5)

UNIT FIVE CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .4 psig↔ (NISA 4/8) ; Temp: 45.5°C↑ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) 3/31);

Primary Containment: Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
946 bundles (JAIF); Temp: 34.7oC↓ (JAIF 4/8); Cooling capability recovered (JAIF 4/1)

Other: On offsite AC power (IAEA 3/28). External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). (b)(4),(b)(5)

(b)(4),(b)(5)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

UNIT 5 - SPENT FUEL POOL STATUS

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

- Unit 5 is stable with cooling capacity recovered.

Unit 5 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 5 Additional Considerations:

- (b)(4),(b)(5)
-

(b)(4),(b)(5)

UNIT SIX CORE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Core Status: (b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)

RPV: pressure .7 psig↔ (NISA 4/8) ; Temp: 22.7°C↔ (NISA 4/8);

Core Cooling: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5)

Primary Containment:
Functional (JAIF, NISA, TEPCO)

Secondary Containment:
Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)

Spent Fuel Pool:
876 bundles (b)(6) Temp: 30.5.0°C↑ (NISA 4/8); (b)(4),(b)(5) (b)(4),(b)(5)

Other: On offsite AC power (b)(4),(b)(5) (b)(4),(b)(5)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

UNIT 6 - SPENT FUEL POOL STATUS

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	(b)(4),(b)(5)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

- Unit 6 is stable with cooling capacity recovered.

Unit 6 Recommendations:

-
- (b)(4),(b)(5)
-

Unit 6 Additional Considerations:

-
- (b)(4),(b)(5)

(b)(4),(b)(5)

COMMON - SPENT FUEL POOL STATUS

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	(b)(4),(b)(5)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

–
– (b)(4),(b)(5)

Common Additional Considerations:

–
– (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. EPRI recommendations March 18, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 24, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1	(b)(4)	292
Unit 2		587
Unit 3		514
Unit 4		1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

The purpose of this document is to provide the NRC Reactor Safety Team's recommendations for the Fukushima-Daiichi reactor plants and spent fuel pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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Simplified Plant Condition Stability Determination

For Discussion with Nuclear and Industrial Safety Agency (NISA)

(b)(4),(b)(5)

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The purpose of this document is to provide the NRC Reactor Safety Team's recommendations for the Fukushima-Daiichi reactor plants and spent fuel pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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(b)(4),(b)(5)

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The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

General Discussion of the Desired End State of all Spent Fuel Pools

(b)(4),(b)(5)

(b)(4),(b)(5)

SPENT FUEL POOL STATUS (2100 April 4th)

Fukushima Daiichi Unit 1

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	11 mR/hr at gate (TEPCO 0800 JT 3/30)
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic spray from concrete pumper truck (b)(5)
Fuel Pool Water Temperature:	10°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. The (b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

- (b)(4),(b)(5)

Unit 1 Additional Considerations:

- (b)(4),(b)(5)

(b)(5)

Fukushima Daiichi Unit 2

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation ration rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	Drywell 3, 999 Rad/hour (R/hr); Torus 128 R/hr (CAMs)
Fuel Pool Level:	Full (b)(6) /3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)

Unit 2 Additional Considerations:

- (b)(4),(b)(5)

(b)(5)

Fukushima Daiichi Unit 3

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	DW 2760 R/hr, torus 111 R/hr (TEPCO 3/30)
Fuel Pool Level:	Full (b)(6) /3)
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper (b)(5)
Fuel Pool Water Temperature:	56°C (JAIF 4/5)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

(b)(5)

Unit 3 Recommendations:

-
- (b)(4),(b)(5)
-

Unit 3 Additional Considerations:

- (b)(4),(b)(5)

(b)(5)

Fukushima Daiichi Unit 4

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28) (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Low water level (b)(6) /1)
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper
Fuel Pool Water Temperature:	42°C (JAIF 4/3)

Con (b)(5)
Con

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

(b)(5)

Unit 4 Recommendations:

-
-
(b)(4),(b)(5)
-
-

Unit 4 Additional Considerations:

-
(b)(4),(b)(5)
-

Fukushima Daiichi Unit 5

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

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(b)(4),(b)(5)
–

Unit 5 Additional Considerations:

–
–
(b)(4),(b)(5)

Fukushima Daiichi Unit 6

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	(b)(4),(b)(5)
Fuel Pool Water Temperature:	28.5°C (Steady) (TECPO 4/5)

Comm (b)(5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

Relatively stable.

Unit 6 Recommendations:

–
(b)(4),(b)(5)
–

Unit 6 Additional Considerations:

– (b)(4),(b)(5)

– (b)(4),(b)(5)

Fukushima Daiichi Common SFP

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/54
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

– (b)(4),(b)(5)

Common Additional Considerations:

–
– (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company.

ENCLOSURE 1

1. **EPRI recommendations March 18, 2011**

(b)(4),(b)(5)

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(b)(4)	1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

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General Discussion of the Desired End State of all Spent Fuel Pools

(b)(4),(b)(5)

(b)(4)

(b)(4),(b)(5)

SPENT FUEL POOL STATUS (2100 April 4th)

Fukushima Daiichi Unit 1

Amount of fuel:	292 bundles (b)(4)
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day (b)(4)
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	11 mR/hr at gate (TEPCO 0800 JT 3/30)
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic spray from concrete pumper truck
Fuel Pool Water Temperature:	No data
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. The (b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

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Unit 1 Recommendations:

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(b)(4),(b)(5)

Unit 1 Additional Considerations:

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–

(b)(4),(b)(5)

Fukushima Dailchi Unit 2

Amount of fuel: 587 bundles (b)(4)

Last transfer from Reactor: 116 bundles (September 20-25, 2010)

Decay Heat [megawatt thermal (MWth)]: 0.47 MWth; evaporation ration rate 5240 gallons per day

Fuel Pool Structural Support Integrity: (b)(4),(b)(5)

Fuel Pool Leak Integrity: No data

Criticality status: No data

Area Radiation Levels: Drywell 3, 999 Rad/hour (R/hr); Torus 128 R/hr (CAMs)

Fuel Pool Level: Full (b)(6) 4/3)

Water Injection Method and Source: Fresh water injected to the spent fuel pool

Fuel Pool Water Temperature: 71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 2 Additional Considerations:

- (b)(4),(b)(5)
-

Fukushima Daiichi Unit 3

Amount of fuel: 514 bundles (b)(4)

Last transfer from Reactor: 148 bundles (June 23 to 28, 2011) (b)(4)

Decay Heat (MWth): 0.23 MWth; evaporation rate 2570 gallons per day

Fuel Pool Structural Support Integrity: Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)

Fuel Pool Leak Integrity: No data

Criticality status: No data

Area Radiation Levels: DW 2760 R/hr, torus 111 R/hr (TEPCO 3/30)

Fuel Pool Level: Full (b)(6) /3)

Water Injection Method and Source: Periodic fresh water injected via concrete pumper

Fuel Pool Water Temperature: 56°C (JAIF 4/5)

Other:

Unit 3 Assessment:

(b)(4),(b)(5)

(b)(4)

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Unit 3 Recommendations:

-
-
-

(b)(4),(b)(5)

Unit 3 Additional Considerations:

-
-

(b)(4),(b)(5)

Fukushima Daiichi Unit 4

Amount of fuel: 1331 bundles (b)(4)

Last transfer from Reactor: 548 bundles (December 5 to December 10, 2010)

Decay Heat (MWth): 1.86 MWth (b)(4)

Fuel Pool Structural Support Integrity: Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4)(

Fuel Pool Leak Integrity: No data

Criticality status: No data

Area Radiation Levels: No data

Fuel Pool Level: Low water level (b)(6) 4/1)

Water Injection Method and Source: Periodic fresh water injected via concrete pumper

Fuel Pool Water Temperature: 42°C (JAIF 4/3) (b)(4)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

- (b)(4),(b)(5)

Unit 4 Additional Considerations:

- (b)(4),(b)(5)

Fukushima Daiichi Unit 5

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

- (b)(4),(b)(5)
-

Unit 5 Additional Considerations:

- (b)(4),(b)(5)
-

Fukushima Daiichi Unit 6

Amount of fuel: 876 bundles

Last transfer from Reactor: 184 bundles (August 10-25 2010)

Decay Heat (MW): 0.7 (MW) (b)(6)

Fuel Pool Structural Support Integrity: Not damaged (JAIF 4/4)

Fuel Pool Leak Integrity: No data

Criticality status: No data

Area Radiation Levels: No data

Fuel Pool Level: Full

Water Injection Method and Source: Residual heat removal in fuel pool cooling mode (NISA 3/25)

Fuel Pool Water Temperature: 28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

Relatively stable.

Unit 6 Recommendations:

- (b)(4),(b)(5)
-

Unit 6 Additional Considerations:

- (b)(4),(b)(5)

- (b)(4),(b)(5)

Fukushima Daiichi Common SFP

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/54
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)

Common Additional Considerations:

-
- (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
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3. Spent Fuel Inventories Document

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NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. **EPRI recommendations March 18, 2011**

(b)(4),(b)(5)

(b)(4)

(b)(4)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor	Spent fuel pool
Unit 1	(b)(4)	292
Unit 2		587
Unit 3		514
Unit 4		1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

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General Discussion of the Desired End State of all Spent Fuel Pools

(b)(4),(b)(5)

(b)(4)

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(b)(4),(b)(5)

SPENT FUEL POOL STATUS (2100 April 4th)

Fukushima Daiichi Unit 1

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	11 mR/hr at gate (TEPCO 0800 JT 3/30) (b)(4)
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic spray from concrete pumper truck (b)(5)
Fuel Pool Water Temperature:	10°C (3/31 0815)
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

(b)(4),(b)(5)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. The (b)(4),(b)(5)

Unit 1 Assessment:

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(b)(4),(b)(5)

Unit 1 Recommendations:

(b)(4),(b)(5)

Unit 1 Additional Considerations:

(b)(4),(b)(5)

(b)(5)

Fukushima Daiichi Unit 2

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation ration rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	Drywell 3, 999 Rad/hour (R/hr); Torus 128 R/hr (CAMs) (b)(4)
Fuel Pool Level:	Full (b)(6) /3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 2 Additional Considerations:

- (b)(4),(b)(5)
- (b)(5)

Fukushima Daiichi Unit 3

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	DW 2760 R/hr, torus 111 R/hr (TEPCO 3/30) (b)(4)
Fuel Pool Level:	Full (b)(6) 3)
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper (b)(5)
Fuel Pool Water Temperature:	56°C (JAIF 4/5)

Other:

Unit 3 Assessment:

(b)(4),(b)(5)

(b)(4)

(b)(4),(b)(5)

Unit 3 Recommendations:

- (b)(4),(b)(5)
-
-

Unit 3 Additional Considerations:

- (b)(4),(b)(5)

(b)(5)

Fukushima Daiichi Unit 4

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper
Fuel Pool Water Temperature:	42°C (JAIF 4/3)

(b)(5)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

(b)(4),(b)(5)

Unit 4 Recommendations:

-
-
-
-

(b)(4),(b)(5)

Unit 4 Additional Considerations:

-
-

(b)(4),(b)(5)

Fukushima Daiichi Unit 5

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling

Fuel Pool Water Temperature: 37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

- (b)(4),(b)(5)
-

Unit 5 Additional Considerations:

- (b)(4),(b)(5)
-

Fukushima Daiichi Unit 6

Amount of fuel: 876 bundles

Last transfer from Reactor: 184 bundles (August 10-25 2010)

Decay Heat (MW): 0.7 (MW) (b)(6)

Fuel Pool Structural Support Integrity: Not damaged (JAIF 4/4)

Fuel Pool Leak Integrity: No data

Criticality status: No data

Area Radiation Levels: No data

Fuel Pool Level: Full

Water Injection Method and Source: Residual heat removal in fuel pool cooling mode (NISA 3/25)

Fuel Pool Water Temperature: 28.5°C (Steady) (TECPO 4/5) (b)(5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

~~Relatively S~~stable.

Unit 6 Recommendations:

- (b)(4),(b)(5)
-

Unit 6 Additional Considerations:

-
- (b)(4),(b)(5)

Fukushima Daiichi Common SFP

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/54
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

- (b)(4),(b)(5)

Common Additional Considerations:

-
-

(b)(4),(b)(5)

REFERENCES

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ENCLOSURE 1

1. **EPRI recommendations March 18, 2011**

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor			Spent fuel pool
Unit 1				292
Unit 2				587
Unit 3				514
Unit 4		(b)(4)		1, 331
Unit 5				946
Unit 6				876
Shared pool				6, 375
total				10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

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Stable Plant Conditions

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Stable Plant Conditions

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(4),(b)(5)

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Working draft as of 4/4/11 - 1300

Stable Plant Conditions

(b)(4),(b)(5)

(b)(4)

(b)(4)

(b)(4),(b)(5)

(b)(4)

(b)(4),(b)(5)

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General Discussion of the Desired End State of all Spent Fuel Pools

(b)(4),(b)(5)

(b)(4),(b)(5)

SPENT FUEL POOL STATUS (2100 April 4th)

Fukushima Daiichi Unit 1

Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	11 mR/hr at gate (TEPCO 0800 JT 3/30)
Fuel Pool Level:	No data
Water Injection Method and Source:	Periodic spray from concrete pumper truck
Fuel Pool Water Temperature:	No data
Power Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)

Other: On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. The (b)(4),(b)(5)

Unit 1 Assessment:

(b)(4),(b)(5)

Unit 1 Recommendations:

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(b)(4),(b)(5)

Unit 1 Additional Considerations:

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–
(b)(4),(b)(5)

Fukushima Daiichi Unit 2

Amount of fuel:	587 bundles
Last transfer from Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation ration rate 5240 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	Drywell 3, 999 Rad/hour (R/hr); Torus 128 R/hr (CAMs)
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Fresh water injected to the spent fuel pool
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)

Other: External AC power has reached the unit, checking the integrity of equipment before energizing. (b)(4),(b)(5)

Unit 2 Assessment:

(b)(4),(b)(5)

Unit 2 Recommendations:

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(b)(4),(b)(5)

Unit 2 Additional Considerations:

–
–

(b)(4),(b)(5)

Fukushima Daiichi Unit 3

Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	DW 2760 R/hr, torus 111 R/hr (TEPCO 3/30)
Fuel Pool Level:	Full (b)(6) 4/3)
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper
Fuel Pool Water Temperature:	56°C (JAIF 4/5)
Other:	

Unit 3 Assessment:

(b)(4),(b)(5)

Unit 3 Recommendations:

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(b)(4),(b)(5)

Unit 3 Additional Considerations:

–

–

(b)(4),(b)(5)

Fukushima Daiichi Unit 4

Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Low water level (b)(6) 4/1)
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper
Fuel Pool Water Temperature:	42°C (JAIF 4/3)

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

Unit 4 Assessment:

(b)(4),(b)(5)

Unit 4 Recommendations:

(b)(4),(b)(5)

Unit 4 Additional Considerations:

(b)(4),(b)(5)

Fukushima Daiichi Unit 5

Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Fuel pool cooling
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 5 Assessment:

Stable.

Unit 5 Recommendations:

–
–

(b)(4),(b)(5)

Unit 5 Additional Considerations:

–
–

(b)(4),(b)(5)

Fukushima Daiichi Unit 6

Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)

Other: External AC power supplying the unit, Unit 6 diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO). Repairs complete on RHR pump used for fuel pool cooling.

Unit 6 Assessment:

Relatively stable.

Unit 6 Recommendations:

–
–

(b)(4),(b)(5)

Unit 6 Additional Considerations:

– (b)(4),(b)(5)

– (b)(4),(b)(5)

Fukushima Daiichi Common SFP

Amount of fuel:	6375 bundles
Last transfer from Reactor:	No data
Decay Heat (MW):	1.2 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Full
Water Injection Method and Source:	Normal cooling (NISA 3/24)
Fuel Pool Water Temperature:	28.0°C (TECPO 4/54
Other:	

Common SFP Assessment:

Relatively stable.

Common SFP Recommendations:

– (b)(4),(b)(5)

Common Additional Considerations:

–
– (b)(4),(b)(5)

REFERENCES

1. EPRI recommendations March 18, 2011
2. SFP Criticality Potential, Kent Wood, March 4, 2011
3. Spent Fuel Inventories Document

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

ENCLOSURE 1

1. EPRI recommendations March 18, 2011

(b)(4),(b)(5)

(b)(4),(b)(5)

ENCLSOURE 2

SFP Criticality Potential, Kent Wood, March 4, 2011

(b)(5)

(b)(5)

ENCLOSURE 3

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor			Spent fuel pool
Unit 1				292
Unit 2				587
Unit 3				514
Unit 4		(b)(4)		1, 331
Unit 5				946
Unit 6				876
Shared pool				6, 375
total				10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi\Industy Spent Fuel Pool Assessment\04-05-11 0400 RST Assessment Spent Fool Pool Document .docx

(b)(4),(b)(5)

(b)(5)

(b)(4),(b)(5)

ENCLOSURE 1

Calculated the injection rate as follows based on TRACG decay heat (1979 ANS 5.1).

(b)(4),(b)(5)

ENCLOSURE 2

CONTAINMENT BYPASS

(b)(4),(b)(5)

(b)(4),(b)(5)

(b)(5)

Feedwater Check Valve Leakage

(b)(4),(b)(5)

(b)(4),(b)(5)

RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 hrs 4/02/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

(b)(4),(b)(5)

UNIT ONE

U1 ASSUMPTIONS OF SPENT FUEL POOL STATUS:

Amount of fuel:

Age of fuel:

Thermal status:

Fuel Pool Structural Support Integrity:

Fuel Pool Leak Integrity:

Criticality status:

Radiation Status:

Other:

U1 ASSESSMENT:

U1 RECOMMENDATIONS FOR CONSIDERATION:

U1 ADDITIONAL CONSIDERATIONS:

UNIT TWO

2200 hrs 4/02/2011

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U2 ASSUMPTIONS:

Amount of fuel:

Age of fuel:

Thermal status:

Fuel Pool Structural Support Integrity:

Fuel Pool Leak Integrity:

Criticality status:

Radiation Status:

Other:

U2 ASSESSMENT:

U2 RECOMMENDATIONS FOR CONSIDERATION:

U2 ADDITIONAL CONSIDERATIONS:

UNIT THREE

U3ASSUMPTIONS:

Amount of fuel:

Age of fuel:

Thermal status:

Fuel Pool Structural Support Integrity:

Fuel Pool Leak Integrity:

Criticality status:

Radiation Status:

Other:

U3 ASSESSMENT:

U3 RECOMMENDATIONS FOR CONSIDERATION:

U3ADDITIONAL CONSIDERATIONS:

UNIT FOUR

U4 ASSUMPTIONS:

Amount of fuel:

Age of fuel:

Thermal status:

Fuel Pool Structural Support Integrity:

Fuel Pool Leak Integrity:

Criticality status:

Radiation Status:

Other:

U4 ASSESSMENT:

U4 RECOMMENDATIONS FOR CONSIDERATION:

U4 ADDITIONAL CONSIDERATIONS:

RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

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(b)(4),(b)(5)

RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

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(b)(4),(b)(5)

RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 hrs 4/02/2011

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Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	Reactor			Spent fuel pool
Unit 1				292
Unit 2				587
Unit 3				514
Unit 4		(b)(4)		1, 331
Unit 5				946
Unit 6				876
Shared pool				6, 375
total				10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	–	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

UNIT ONE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

SFP Status: (b)(4),(b)(5)

Rad levels: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO)

External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. (b)(4),(b)(5)
(b)(4),(b)(5)

Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)
(b)(4),(b)(5)

ASSESSMENT:

(b)(4),(b)(5)

RECOMMENDATIONS: (b)(4),(b)(5)
(b)(4),(b)(5)

- (b)(4),(b)(5)
-
-

Additional Considerations

A. (b)(4),(b)(5)

B.

UNIT TWO

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RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 hrs 4/02/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

SFP Status: (b)(4),(b)(5)

(b)(4),(b)(5)

Rad Levels: Drywell 3999 R/hr; Torus 128 R/hr (CAMS);

Outside plant: 11 mR/hr at gate (variable) (TEPCO 0700 JDT 3/30)

Other: External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5)

ASSESSMENT:

(b)(4),(b)(5)

RECOMMENDATIONS: (b)(4),(b)(5)

(b)(4),(b)(5)

- ➢
- ➢ (b)(4),(b)(5)
- ➢

Additional Considerations

A. (b)(4),(b)(5)

B. (b)(4),(b)(5)

UNIT THREE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

SFP Status: (b)(4),(b)(5)

Rad Levels: DW 2760 R/hr, torus 111 R/hr (3/30/11 TEPCO);

Outside plant: 11 mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).

Other: External AC power has reached the unit, checking integrity of equipment before energizing. In Unit 3, lighting distribution panels are being checked.

ASSESSMENT:

(b)(4),(b)(5)

RECOMMENDATIONS: (b)(4),(b)(5)

(b)(4),(b)(5)

- (b)(4),(b)(5)
-
-

RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 hrs 4/02/2011

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Additional Considerations

A.
B. (b)(4),(b)(5)

UNIT FOUR

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

SFP Status: (b)(4),(b)(5)

(b)(4),(b)(5)

Rad Levels:
No information.

Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

(b)(4),(b)(5)

RECOMMENDATIONS: (b)(4),(b)(5)

(b)(4),(b)(5)

**RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE .**

2200 hrs 4/02/2011
The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

- (b)(4),(b)(5)

Additional Considerations

A. (b)(4),(b)(5)

B.

UNIT FIVE

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Spent Fuel Pool:
Fuel pool cooling functioning Temperature 37.9 °C (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable.

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling. (b)(4),(b)(5)

Monitor

RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0),
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 hrs 4/02/2011

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UNIT SIX

ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

Spent Fuel Pool:
Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)

Other: External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable.

RECOMMENDATIONS:

1. Monitor

ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA – Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0), Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 hrs 4/02/2011

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Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

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	Reactor	Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(b)(4)	1, 331
Unit 5		946
Unit 6		876
Shared pool		6, 375
total		10, 921

Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	—	1, 180

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Supplemental Information on Venting (Q385) – Rev. 6

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

2200 Hrs 04/02/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

Supplemental Information on Venting

(b)(4),(b)(5)

Supplemental Information on Venting (Q385) – Rev. 6

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(b)(4),(b)(5)

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(b)(4),(b)(5)

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Supplemental Information on Venting (Q385) – Rev. 6

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

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(b)(4),(b)(5)

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Supplemental Information on Venting (Q385) – Rev. 6

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

1800 Hrs 04/02/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

Radiological considerations:

(b)(4),(b)(5)

Drywell radiation levels:

(b)(4),(b)(5)

Meteorological conditions: (b)(4),(b)(5)

(b)(4),(b)(5)

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Supplemental Information on Venting (Q385) – Rev. 6

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

1800 Hrs 04/02/2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

(b)(4),(b)(5)

<u>1F1 vent status:</u>

(b)(4),(b)(5)

Supplemental Information on Venting (Q385) – Rev. 6

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

1800 Hrs 04/02/2011

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Generic Consideration of Containment Venting (EPRI TBR & BWR EPG/SAG)

(b)(4),(b)(5)

References:

EPRI TR-101869, Severe Accident Management Guidance Technical Basis Report, Vol 1, dated December 1992

BWROG Emergency Procedure and Severe Accident Guidelines, Appendix B: Technical Basis, Volume 2, dated March 2001

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Key Agency/Organization Input to **Supplemental Information on Venting (REV 6)** Document

Table of Senior/Approving Officials

AGENCY/ ORGANIZATION	CONCURRENCE STATEMENT	SENIOR REVIEWING OFFICIAL	TITLE	AS REPORTED BY
Naval Reactors, KAPL & BETTIS				
GE Hitachi				
INPO				
DOE/NE		(b)(4),(b)(5),(b)(6)		
EPRI				
USNRC				

DRAFT Proposal for inclusion into Rev 1 of RST Assessment Document

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Status of Fukushima Daiichi Reactors
29 March 2011
As of 0600 (EDT)

(b)(4),(b)(5)

(b)(4),(b)(5)

- NHK WORLD Reports: Tuesday, March 29, 2011 02:21 +0900 (JST) that TEPCO has reported that very high levels of radiation have been observed in water in a trench just outside the turbine building for one of the reactors.

  Tokyo Electric Power Company announced on Monday that a puddle of water was found in a trench outside the No. 2 reactor turbine building at the Fukushima Daiichi nuclear plant on Sunday afternoon. It said the radiation reading on the puddle's surface indicated more than 1,000 millisieverts per hour.

  The concrete trench is 4 meters high and 3 meters wide and houses power cables and pipes. It is located in the compound of the plant but outside the radiation control area.
  TEPCO says the trench extends 76 meters toward the sea but does not reach the sea, and that the contaminated water was not flowing into the sea.

  TEPCO says it is trying to find out how the contaminated water came to be in the trench.

  Puddles of water were also found in the trenches outside the No. 1 and No. 3 reactors. TEPCO reported 0.4 millisieverts of radiation on the surface of the puddle in the No. 1 reactor's trench. But it said it failed to measure the No. 3

reactor's trench because it was covered with debris.

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Sources include:
Federation of Electric Power Companies of Japan
Nuclear Industrial Safety Agency

Links:

http://www.jaif.or.jp/english/

http://www.tepco.co.jp/en/index-e.html

http://nei.cachefly.net/newsandevents/information-on-the-japanese-earthquake-and-reactors-in-that-region/

http://www.iaca.org/

http://www.mext.go.jp/english/

https://iportalwc.doe.gov/

http://www.nisa.meti.go.jp/english/

http://www.fepc.or.jp/english/

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 245, 2011

UNIT ONE

STATUS:

Core Status: (b)(4),(b)(5)

The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL).

(b)(4),(b)(5)

Vessel temperatures 230C at bottom drain, 240C at FW nozzle (b)(6) 0430 JDT 3/24)

(b)(4),(b)(5)

Core Cooling: (b)(4),(b)(5) injecting through feedwater 119 l/min (JAIF), or TEPCO) Recirculation pump seals have likely

(b)(4),(b)(5)

Primary Containment: N... psia (TEPCO is considering venting on 3/24)

Secondary Containment: Severely damaged (hydrogen explosion)

Spent Fuel Pool: Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)

Rad levels: DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant less than 6R/hr (TEPCO 9pm 3/20/11)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1 & U-3.

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting seawater through the feedwater system is cooling the vessel but limited if any flow past the fuel. GE believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. (b)(4),(b)(5) There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 245, 2011

RECOMMENDATIONS:

(b)(4),(b)(5)

- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert. (b)(6)
  - Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation. (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water. Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5)
  - (b)(4),(b)(5) Containment spray should be secured before 2 lbs. to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment. (b)(6)

- (b)(4),(b)(5)
  - Borate water if possible. (b)(4),(b)(5)
  - (b)(4),(b)(5)
- Ensure SFP level maintained as full as possible.
- (b)(4),(b)(5)

(b)(4),(b)(5)

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- (b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel

(b)(4),(b)(5)

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 24 5, 2011

UNIT TWO

STATUS:

Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO).
	Suspect the volume of sea water injected to cool the core has left enough ... lower plenum to the core plate (GEH, INPO, Bettis, KAPL).
	(b)(4),(b)(5) , bottom head temperature 105C, feed water ... pump (b)(4),(b)(5)
Primary Containment:	Damage ... (JAIF, NISA, TEPCO)
Secondary Containment:	Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)
Spent Fuel Pool:	Fuel covered, seawater injected on March 20, fuel pool temperature 40C (JAIF, NISA, TEPCO)
Rad Levels:	Drywell 4590 R/hr; Torus 193 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:

- (b)(4),(b)(5)

(b)(4),(b)(5)

- (b)(4),(b)(5)
- Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
  - Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
  - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)
- (b)(4),(b)(5)
  - (b)(4),(b)(5) Containment spray should be secured before 2 lbs. to prevent opening vacuum breakers.
- (b)(4),(b)(5)
- When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
- (b)(4),(b)(5)
- Borate water if possible (b)(4),(b)(5)

(b)(4),(b)(5)

Ensure SFP level maintained as full as possible

(b)(4),(b)(5)

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(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 2~~4~~5, 2011

- (b)(4),(b)(5)
- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

(b)(4),(b)(5)

~~Official Use Only~~

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 245, 2011

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) suspect the volume of sea water injected to cool the core has left enough salt to likely fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL)
Core Cooling	Seawater injection through RHR, bottom head temperature 185C, feed water nozzle temperature 81C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(6) Expect to go freshwater cooling late on 3/25
Primary Containment	Damage suspected ~~suspected~~ (~~JAIF,~~ NISA, TEPCO) Not damaged (JAIF 22:00 3/24)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 6000 R/hr, torus 158 R/hr (source instruments unknown)
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPC~~o~~O of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4).(NR).

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 24~~5~~, 2011

RECOMMENDATIONS:

- (b)(4),(b)(5)

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  - Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but do not delay venting or spraying the containment if that is needed, just to inert - (b)(6)
    - Steam/condensing could jeopardize inert environment , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)
    - Hydrogen gas production more prevalent in salt water than in fresh water Oxygen from the injected seawater may come out of solution and create a hazardous atmosphere inside primary containment. The radiolysis of water will generate additional oxygen. (b)(6)

(b)(4),(b)(5)

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(b)(4),(b)(5) Containment spray should be secured before 2 lbs. to prevent opening vacuum breakers

  - (b)(4),(b)(5)
  - When flooding containment consider the implications of water weight on seismic capability of containment (b)(6)

- (b)(4),(b)(5)
  - Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
- Ensure SFP level maintained as full as possible

(b)(4),(b)(5)

(b)(4),(b)(5)

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 24~~4~~5, 2011

(b)(4),(b)(5)

- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

(b)(4),(b)(5)

GEH: No markups
3-25-11

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 2~~4~~5, 2011

UNIT FOUR

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature back up to 100 C (NISA); (b)(4),(b)(5) 3/24
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel may have been ejected from the pool (based on information from TEPCo of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 245, 2011

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling not functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ 0245 EDT March 245, 2011

UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

(b)(4),(b)(5)

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RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
~~2000~~ <u>0245</u> EDT March 24<u>5</u>, 2011

ABBREVIATIONS:

GEH – (b)(4),(b)(5) (b)(4),(b)(5)
INPO – Institute of Nuclear Powe
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

(b)(4),(b)(5)

Status of Fukushima Daiichi Reactors
2~~6~~7 March 2011
As of ~~200~~600 (EDT)

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Sources include:
Federation of Electric Power Companies of Japan
Nuclear Industrial Safety Agency

Links:

http://www.jaif.or.jp/english/ — Field Code Changed

http://www.tepco.co.jp/en/index-e.html — Field Code Changed

http://nei.cachefly.net/newsandevents/information-on-the-japanese-earthquake-and-reactors-in-that-region/ — Field Code Changed

http://www.iaea.org/ — Field Code Changed

http://www.mext.go.jp/english/ — Field Code Changed

https://iportalwc.doe.gov/ — Field Code Changed

http://www.nisa.meti.go.jp/english/ — Field Code Changed

http://www.fepc.or.jp/english/ — Field Code Changed

RST Response to Questions from Japan Team
20:30 EDT March 25, 2011

(b)(5)

(b)(5)

UNIT ONE

ASSUMPTIONS: (based on input from multiple data source: JAI, NISA, TEPCO, & GEH)

Core Status: Core is contained in the reactor pressure vessel, reactor water level is unknown The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL).
Vessel temperatures 149C at bottom drain, 197C at FW nozzle (NISA 1800 JDT 3/25)
RPV at 65.7 psia (increasing trend), DW and torus pressure at 40 psia (decreasing trend) (NISA 1800 JDT 3/25).

Core Cooling: Currently fresh water injection with no boron, injecting through feedwater 120 l/min or 31.7 g/m (NISA); Injection flow rate will be maintained above the minimum debris retention injection rate (MDRIR). Recirculation pump seals have likely failed. (GEH) ;Injection flow rate above MDRIR could not be maintained through core spray. Assume RHR is not available.

Primary Containment: Not damaged, 40 psia [redacted] (b)(4),(b)(5)

Secondary Containment: Severely damaged (hydrogen explosion)

Spent Fuel Pool: Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)

Rad levels: DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant: 26mR/hr at gate (variable) (INPO 0900 hrs 3/25/11)

Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1.

Reactor water is in the Turbine Building basement (NISA)

[redacted] (b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GE believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

(b)(4),(b)(5)

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

-

(b)(4),(b)(5)

(b)(5)

b. Additional Miscellaneous considerations
   1. When flooding containment, consider the implications of water weight on seismic capability of containment .
   2. Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
   3. Ensure Spent Fuel Pool level is maintained as full as possible
   4. CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

c. Potential methods for monitoring containment level:
   1. HPCI suction pressure
   2. Drywell instrument taps
   3. Radiation monitoring instruments

RST Assessment of Fukushima Daiichi Units,

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0600 EDT March 26, 2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT ONE

ASSUMPTIONS: (based on input from multiple data source: JAI, NISA, TEPCO, & GEH)

Core Status:	Core is contained in the reactor pressure vessel, reactor water level is unknown The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL). Vessel temperatures 149C at bottom drain, 197C at FW nozzle (NISA 1800 JDT 3/25) RPV at 65.7 psia (increasing trend), DW and torus pressure at 40 psia (decreasing trend) (NISA 1800 JDT 3/25).
Core Cooling:	Currently fresh water injection with no boron, injecting through feedwater 120 l/min or 31.7 g/m (NISA); Injection flow rate will be maintained above the minimum debris retention injection rate (MDRIR). Recirculation pump seals have likely failed. (GEH) ;Injection flow rate above MDRIR could not be maintained through core spray. Assume RHR is not available.
Primary Containment:	Not damaged, 40 psia Drywell, Torus hydrogen and oxygen concentrations are unknown; The status of the nitrogen purge capability is unknown. An explosive mixture is possible.
Secondary Containment:	Severely damaged (hydrogen explosion)
Spent Fuel Pool:	Fuel covered, no seawater injected - (JAIF, NISA, TEPCO) The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)
Rad levels:	DW 4780 R/hr, Torus 3490 R/hr (source instruments unknown), Outside plant: 26mR/hr at gate (variable) (INPO 0900 hrs 3/25/11)
Other:	Electric power available, equipment testing in progress (JAIF, NISA, TEPCO) External AC power to the Main Control Room of U-1 became available at 11:30 JDT 3/24/2011. Lighting in Main Control Room operating in U-1. Reactor water is in the Turbine Building basement (NISA)

(b)(4),(b)(5)

ASSESSMENT:

Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater system is cooling the vessel but limited if any flow past the fuel. GE believes that water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. There is likely no water level inside the core barrel. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

The fuel pool is slowly heating and has not reached saturation. Overhead photos (on~3/19) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

-

(b)(4),(b)(5)

b. Additional Miscellaneous considerations
   1. When flooding containment, consider the implications of water weight on seismic capability of containment .
   2. Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
   3. Ensure Spent Fuel Pool level is maintained as full as possible
   4. CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

c. Potential methods for monitoring containment level:
   1. HPCI suction pressure
   2. Drywell instrument taps
   3. Radiation monitoring instruments

UNIT TWO

STATUS:

Core Status: Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO).

(b)(4),(b)(5)

Core Cooling: Fresh water with boric acid injection (TEPCO), bottom head temperature 104C, feed water nozzle temperature 107C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (Industry)

Primary Containment: Damage suspected (JAIF, NISA, TEPCO)

Secondary Containment: Damaged (JAIF, NISA, TEPCO), hole in refuel floor siding (visual)

Spent Fuel Pool: Fuel covered, seawater injected on March 20, fuel pool temperature 52C (JAIF, NISA, TEPCO 1800 JDT 3/25/11)

Rad Levels: Drywell 4560 R/hr; Torus 154 R/hr (source instruments unknown); Outside plant: 26mR/hr at gate (variable) (Industry)

Other: External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RPV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS: (for consideration to stabilize Unit 2)

-

(b)(4),(b)(5)

b. Additional Miscellaneous considerations
   1. When flooding containment, consider the implications of water weight on seismic capability of containment .
   2. Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
   3. Ensure Spent Fuel Pool level is maintained as full as possible
   4. CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

c. Potential methods for monitoring containment level:

1. HPCI suction pressure
2. Drywell instrument taps
3. Radiation monitoring instruments

RST Assessment of Fukushima Daiichi Units,

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0600 EDT March 26, 2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT THREE

STATUS:

Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) [redacted] (b)(4),(b)(5)
Core Cooling	Freshwater injection via fire line initiated 1802 JDT 3/25/11 (NISA), bottom head temperature 111C, feed water nozzle temperature Unreliable (JAIF, NISA 1800 JDT 3/25/11, TEPCO) Recirculation pump seals have likely failed. ; Expect to go freshwater cooling late on 3/25
Primary Containment	Damage suspected (NISA, TEPCO) "Not damaged" (JAIF 10:00 3/25)
Secondary Containment	Damaged (JAIF, NISA, TEPCO)
Spent Fuel Pool	Low water level (JAIF, NISA, TEPCO), spraying and pumping sea water into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW 5100 R/hr, torus 150 R/hr (Industry); Outside plant: 26mR/hr at gate (variable) (Industry); 100 R/hr debris outside Rx building (covered).
Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

ASSESSMENT:

Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. Water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RPV level at one half core height, the reactor vessel water level is believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation believed impeded by core damage. It is difficult to determine how much cooling is getting to the fuel. Vessel temperature readings are likely metal temperature which lags actual conditions.

Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4). Unit 3 turbine building basement is flooding. Samples of water indicate some RCS fluid is present

(TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.

RECOMMENDATIONS: (for consideration to stabilize Unit 1)

1.

2.

3.

4.

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6.

(b)(4),(b)(5)

b. Additional Miscellaneous considerations
   1. When flooding containment, consider the implications of water weight on seismic capability of containment .

2. Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)
3. Ensure Spent Fuel Pool level is maintained as full as possible
4. CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.

c. Potential methods for monitoring containment level:
   1. HPCI suction pressure
   2. Drywell instrument taps
   3. Radiation monitoring instruments

RST Assessment of Fukushima Daiichi Units,
Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0600 EDT March 26, 2011
The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

UNIT FOUR

STATUS:

Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling	Not necessary (JAIF, NISA, TEPCO)
Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating up very slowly (JAIF, NISA, TEPCO) Temperature is unknown (NISA); (b)(4),(b)(5)
Rad Levels:	
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

ASSESSMENT:

Given the amount of decay heat in the fuel in the pool, it is likely that in the days immediately following the accident, the fuel was partially uncovered. The lack of cooling resulted in zirc water reaction and a release of hydrogen. The hydrogen exploded and damaged secondary containment. The zirc water reaction could have continued, resulting in a major source term release.

Fuel particulates may have been ejected from the pool (based on information of neutron emitters found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 3).

RECOMMENDATIONS:

- Maintain coverage of spent fuel pool with fresh borated water
- As possible, put spent fuel cooling and cleanup in service

UNIT FIVE

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning Temperature 37.9 C (NISA 1800 3/25/11) (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, Unit 6 (?) diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit five is relatively stable

RECOMMENDATIONS:

Repairs complete on RHR pump used for fuel pool cooling.

Monitor

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UNIT SIX

STATUS:

Core Status:	In vessel (JAIF, NISA, TEPCO)
Core Cooling:	Functional (JAIF, NISA, TEPCO)
Primary Containment:	Functional (JAIF, NISA, TEPCO)
Secondary Containment:	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Pool:	Fuel pool cooling functioning. Temperature 22 C (NISA 1800 JDT 3/25/11) (JAIF, NISA, TEPCO)
Other:	External AC power supplying the unit, diesel generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, TEPCO)

ASSESSMENT:

Unit Six is relatively stable

RECOMMENDATIONS:

- Monitor

Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE
0600 EDT March 26, 2011
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ABBREVIATIONS:

GEH – General Electric Hitachi
INPO – Institute of Nuclear Power Operations
JAIF – Japan Atomic Industrial Forum
NISA - Nuclear and Industrial Safety Agency
TEPCO – Tokyo Electric Power Company

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Additional Measures in Light of TEPCO Current Strategy

(b)(4),(b)(5)

Issued Rev. 2

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(b)(5)

Issued Rev. 2

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(b)(5)

ENCLOSURE 1

CONTAINMENT BYPASS

(b)(5)

Issued Rev. 2

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(b)(5)

Issued Rev. 2

2100 EDT Saturday, April 09, 2011

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(b)(5)

ENCLOSURE 2

Calculated the injection rate as follows based on TRACG decay heat (1979 ANS 5.1).

(b)(5)

(b)(5)