(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.

UNIT ONE

STATUS:

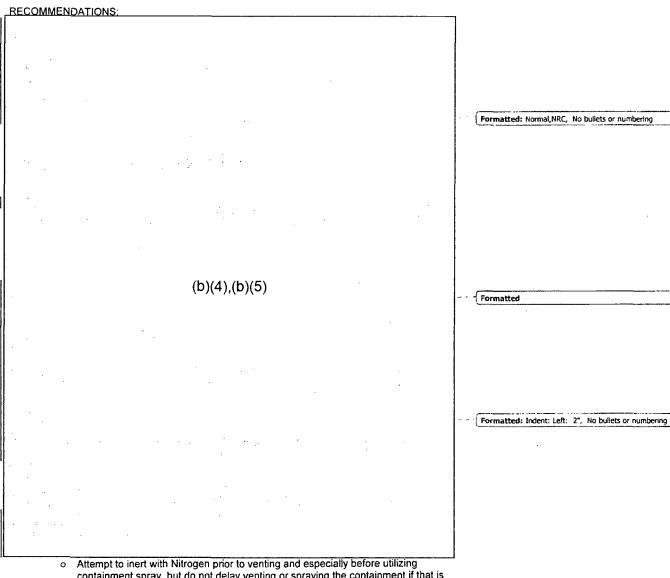
	Core Status:	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) The volume of sea water injected to cool the core has left enough salt to fill the lower plenum to the core plate (GEH, INPO, Bettis, KAPL). Vessel temperatures 149230C at bottom drain, 197240C at FW nozzle (b)(6) p430 JDT-3/24) (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:	<u>Fresh water injection initiated at 1537 hrs.JDT 3/25Saltwater-injection</u> , injecting through feedwater <u>120119 //min-(JAIF)</u> , er-300l/min <u>or 31.7 g/m</u> (NISA), or <del>7gsl/min (TEPCO)</del> ; Recirculation pump seals have likely failed. (GEH); Expect to go to freshwater late on 3/25
ł	Primary Containment:	Not damaged, $4053$ psia (TEPCO was considering venting on 3/24)
	Secondary Containment:	Severely damaged (hydrogen explosion)
ļ	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 <u>3900?4780</u> R/hr, Torus <u>2490?</u> 3490 R/hr (source instruments unknown), Outside plant <u>100R/hr debris outside Rx building (covered); 26mR/hr at gate</u> (variable)-less-than-6R/hr (INPO 0900 hrs <u>3/25/11</u> 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	2

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 <u>fresh waterseawater</u> 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)

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.

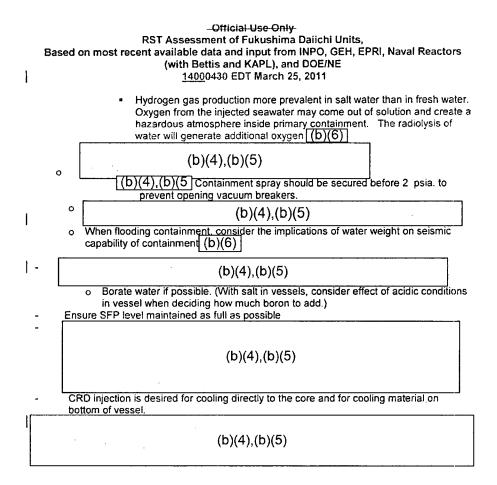
The fuel pool is slowly heating and has not reached saturation. Overhead photos ( $on \sim 3/19$ ) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.



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)



#### UNIT TWO

STATUS: Core Status:

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s: 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
I	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 $\underline{52}49C$ (JAIF, NISA, TEPCO_1800 JDT 3/25/11)
I	Rad Levels:	Drywell 45604560 R/hr; Torus 154193 R/hr (source instruments unknown)
	Other:	External AC power has reached the unit, checking integrity of equipment before energizing.

#### ASSESSMENT:

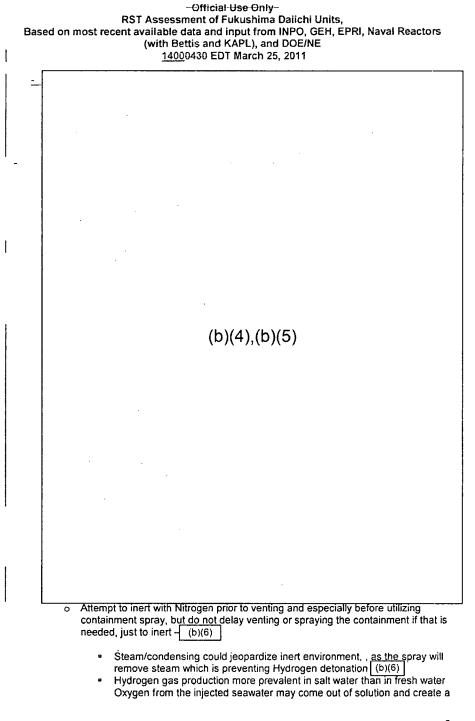
Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

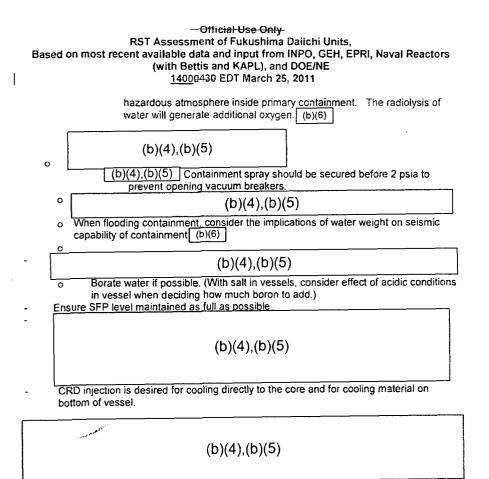
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RV level at one half core height, the reactor vessel water level 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.

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





#### UNIT THREE

STATUS:

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Core Status	Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) (b)(4),(b)(5)
Core Cooling	<u>Freshwater injection via fire line initiated 1802 JDT 3/25/11</u> (NISA)Seawater injection through RHR, bottom head temperature <u>111485</u> C, feed water nozzle temperature <u>Unreliable81</u> C (JAIF, NISA <u>1800 JDT 3/25/11</u> , 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), <u>spraying and pumping sea water</u> into the SFP via the Cooling and Purification Line (NISA)
Rad Levels:	DW <u>5100</u> 6000 R/hr, torus <u>150</u> 458 R/hr (b)(6) <u>0900 3/25/11 Call</u> 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.

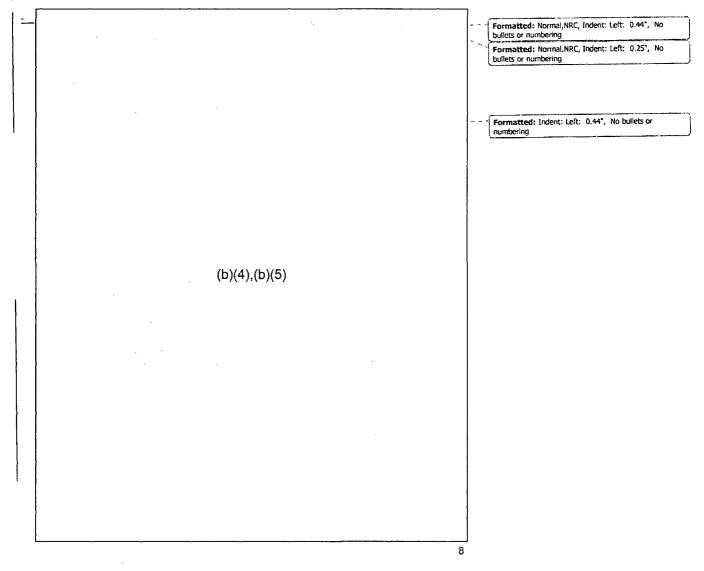
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4).(b)(5) water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RV level at one half core height, the reactor vessel water level 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.

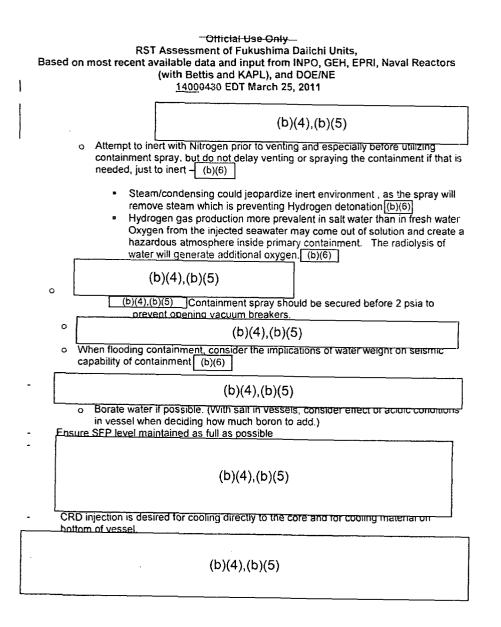
Low level release path: fuel damaged, reactor coolant system potentially breached at Recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

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:





EY 10 of 942

#### UNIT FOUR

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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 unknownback-up to 100 G (NISA) (b)(4),(b)(5)
Rad Levels:	(b)(4),(b)(5)

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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# UNIT FIVE

1

#### 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 <u>Temperature 37.9 C (NISA 1800</u> <u>3/25/11) (</u> 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

# <u>UNIT SIX</u>

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STATUS:
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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 <u>Temperature 22 C (NISA 1800 JDT</u> <u>3/25/11)</u> (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

# 2 - 2:10

# 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. 120I/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:

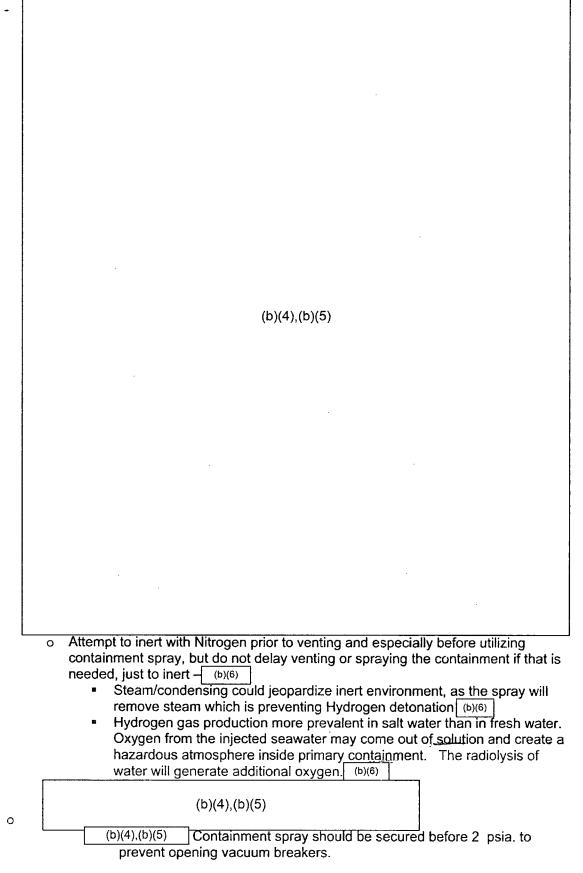
Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting fresh water through the feedwater 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. (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 ( $on \sim 3/19$ ) 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



EY 16 of 942

	o (b)(4),(b)(5)
_	<ul> <li>When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)</li> </ul>
-	(b)(4),(b)(5)
- 1	<ul> <li>Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)</li> <li>Ensure SFP level maintained as full as possible</li> </ul>
-	(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)

# 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:	
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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

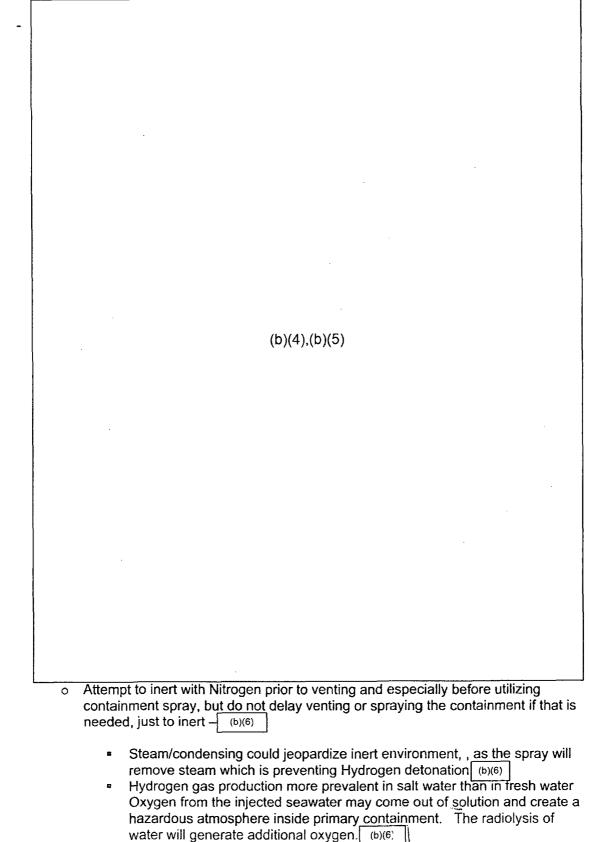
(b)(4) (b)(5) Based on the reports of RV level at one half core height, the reactor vessel water reverse believed to be even with the level of the recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication 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.

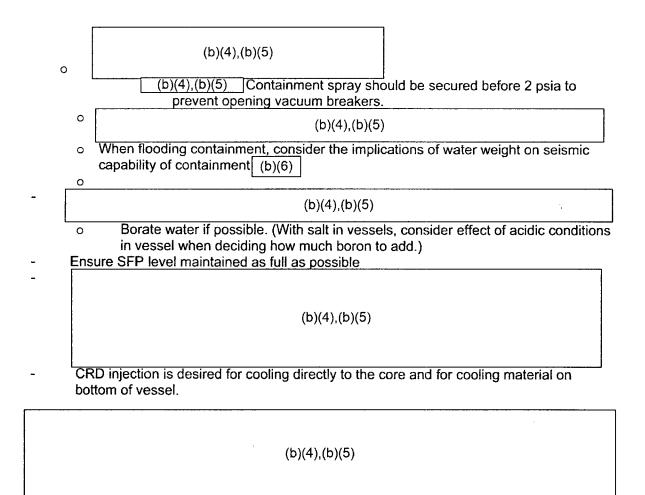
Low level release path: fuel damaged, reactor coolant system potentially breached at recirculation pump seals, primary containment damaged resulting in low level release. There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up but is adequately cooled.

EY 18 of 942

#### **RECOMMENDATIONS:**





#### 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:

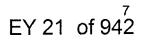
Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

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

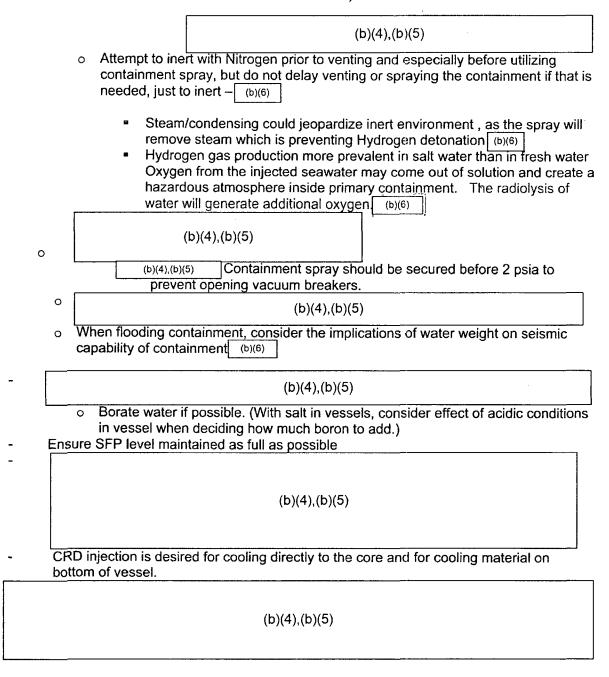


the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material could have come from Unit 4) (b)(6) Unit 3 turbine building basement is flooding. Samples of water indicate some RCS fluid is present (TEPCO sample table – 3/25/11). (b)(4),(b)(5)

(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:

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



#### UNIT FOUR

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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: Rad Levels:	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
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 buildozed 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

# 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

# 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

EY 27 of 942

From: Sent: To: Subject: Attachments: Evans, Michele Friday, March 25, 2011 3:16 PM McDermott, Brian; Holahan, Patricia; Correia, Richard FW: <del>SENSITIVE OUO</del> - RST Assessment 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 OUD - RST Assessment

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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

#### 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:

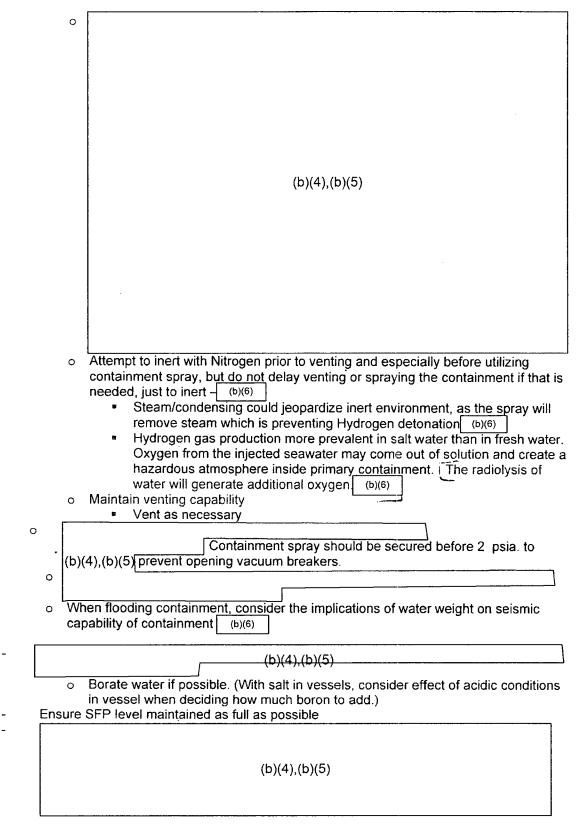
Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting seawater through the feedwater system 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 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 ( $on \sim 3/19$ ) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

RECO	MMENDATIONS:		
-		(b)(4),(b)(5)	



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EY 30 of 942

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

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

#### 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.

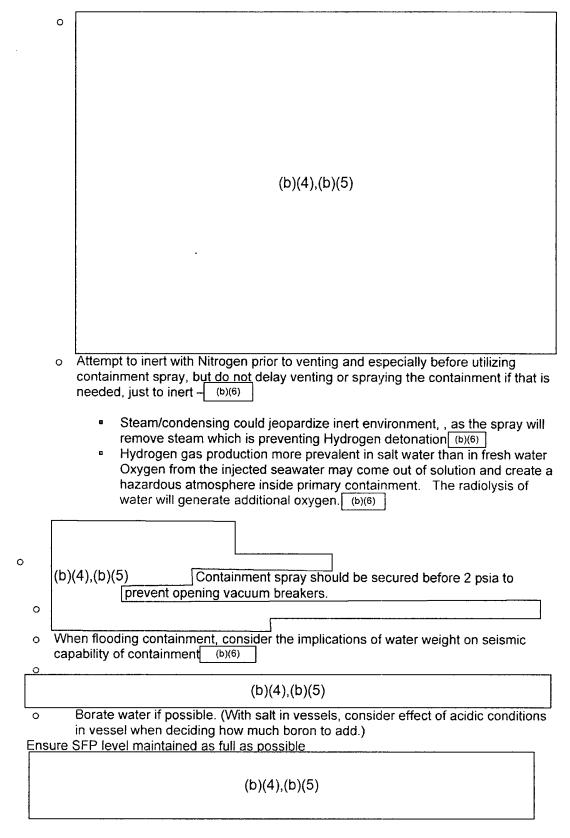
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow

height, the reactor vessel water lever 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.

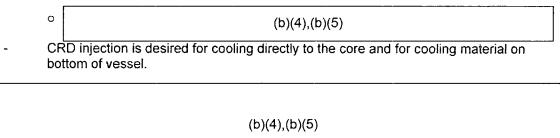
Fuel pool is heating up but is adequately cooled.

RECOMMENDATIONS:		· · · · ·	
-	(b)(4),(b)(5)		



5

EY 33 of 942



EY 34 of 942

#### 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.

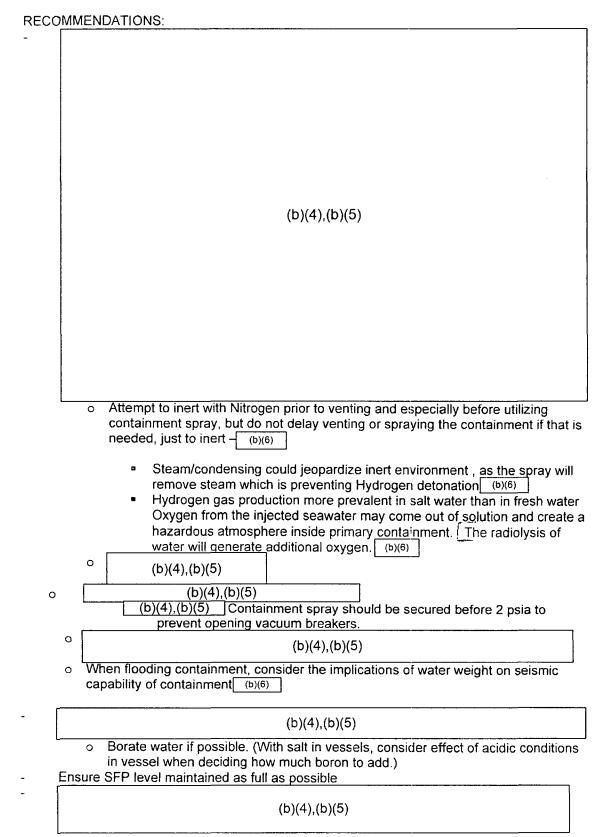
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel (b)(4) (b)(5)

(b)(4). (b)(5) Based on the reports of RV level at one half core height, the reactor vessel water reverse 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)

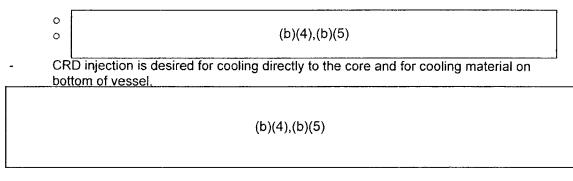
# Official Use Only RST Assessment of Fukushima Daiichi Units, Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE 0430 EDT March 25, 2011



8

EY 36 of 942

# 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



EY 37 of 942

# -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 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: Rad Levels:	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)
Rau 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

# 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 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)

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# ASSESSMENT:

Unit five is relatively stable

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# **RECOMMENDATIONS:**

Finish repairs on RHR pump used for fuel pool cooling.

Monitor

# -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 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

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# **RECOMMENDATIONS:**

- Monitor

# 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

# 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

EY 41 of 942

1	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 2009_0430 EDT March 24 <u>5</u> , 2011	
	UNIT ONE	
	STATUS:	
-	Core Status:	Damaged, fuel partially or fully exposed (JAIF. NISA, TEPCO)
1		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).
1		Vessel temperatures 230C at bottom drain, 240C at FW nozzle (b)(6) 0430 JDT 3/24)
1		RPV, DW and torus pressure increasing as a result of increased flow $\frac{b(6)}{b(6)}$ 0430 JDT3/24).
	Core Cooling:	SaltwaterFreshwater injection, injecting through feedwater 119 l/min (JAIF), or 3001/min (NISA), or 7gal/min (TEPCO); Recirculation pump seals have likely failed. (GEH); Expect to go to freshwater late on 3/25
I	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	r:
	the core is likel	that may have slumped to the bottom of the core and fuel in the lower region of y encased in salt and core flow is severely restricted and likely blocked. The zles are likely salted up restricting core spray flow. Injecting sequater through

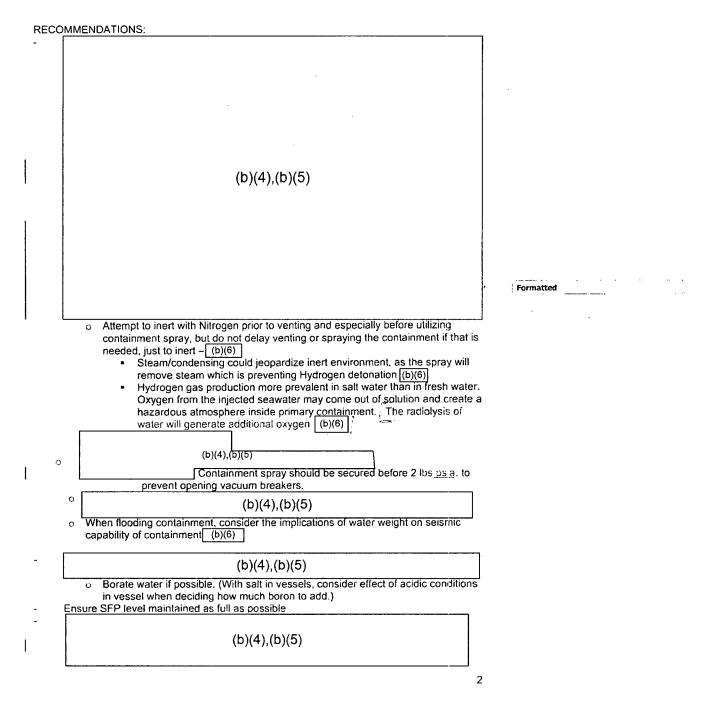
the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting seawater through the feedwater system is cooling the vessal but limited if any flow past the fuel (D)(4), (D)(5)

(b)(4),(b)(5) I nere 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 ( $\underline{on} \sim 3/19$ ) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

#### 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 2090 0430 EDT March 245, 2011



## 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 0430 EDT March 245, 2011

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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)

#### 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 0430 EDT March 245, 2011

## UNIT TWO

1

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 tale 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) Besed 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)

ł	-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 2090_0430_EDT March 245, 2011	
	o (b)(4),(b)(5)	
	<ul> <li>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)</li> <li>Steam/condensing could jeopardize inert environment, as the spray will remove steam which is preventing Hydrogen detonation (b)(6)</li> <li>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)</li> </ul>	Formatted
I	<ul> <li>(b)(4),(b)(5)</li> <li>Containment spray should be secured before 2 #spsia_to</li> <li>prevent opening vacuum breakers.</li> <li>(b)(4),(b)(5)</li> <li>When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)</li> </ul>	
-     	(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	Formatted: Indent: Hanging: 0.5"
	(b)(4),(b)(5)	Formatted: Indent: Left: 0.5", Hanging: 0.5" j

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EY 46 of 942

# Cofficial 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\_0430 EDT March 24<u>5</u>, 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)

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EY 47 of 942

#### -<del>Official Use Only...</del> 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<u>5</u>, 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 <u>suspected suspected</u> (JAIF, NISA, TEPCO) <u>Not damaged</u> (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:

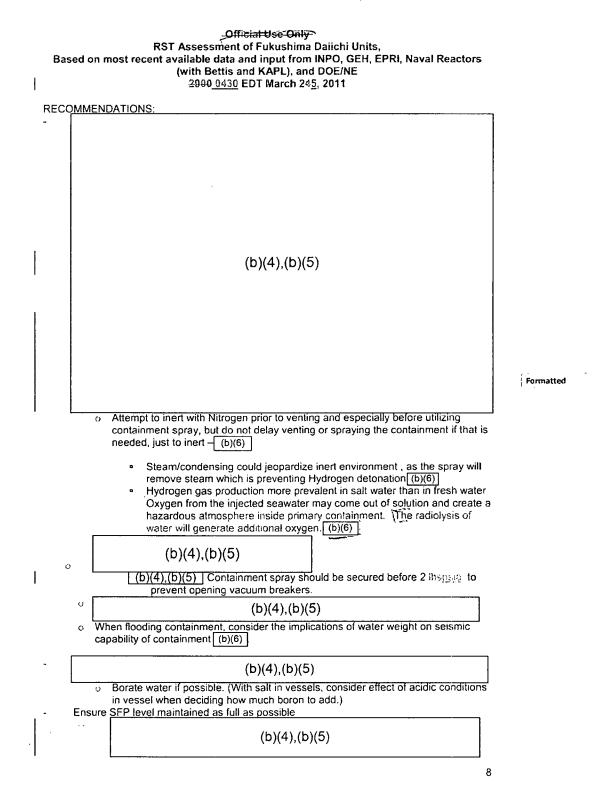
Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

Injecting seawater, through the RHR system is cooling the vessel, but with limited, flow nast the fuel (h)(A) (h)(5)

be affected due to continued salt build up, RPV water level at one half core for 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 polentially 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 TEPCeQ 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).



EY 49 of 942

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-	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_0430 EDT March 24 <u>5</u> , 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)

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#### Official GSC 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 0430 EDT March 245, 2011

## UNIT FOUR

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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)
Rad Levels:	(b)(4),(b)(5)
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)
ACCECCMENT	

#### 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 buildozed 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

## 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\_0430 EDT March 24<u>5</u>, 2011

## UNIT FIVE

1

## 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

## 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\_0430 EDT March 24<u>5</u>, 2011

## UNIT SIX

## STATUS:

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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

## **RÉCOMMENDATIONS:**

- Monitor

## official Use-Onty 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<u>5</u>, 2011

ABBREVIATIONS:

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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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EY 54 of 942

From:	RST01B Hoc
Sent:	Friday, March 25, 2011 3:04 PM
То:	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	(1)/(2)
To: Huckaby, Thomas S.(INPO); Garchow, David F.(INPO); (b)(6) IRST01 Hoc	(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	
(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

<u>To:</u>∫

(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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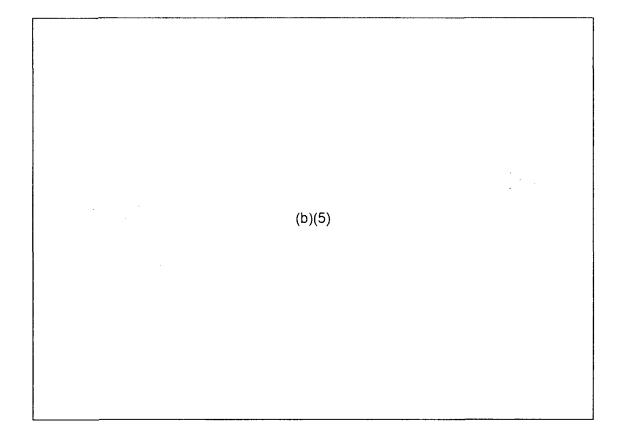
Int'l Toll: 1-719-457<u>-6</u>443 US/CAN Toll Free: 1-888-394-8197

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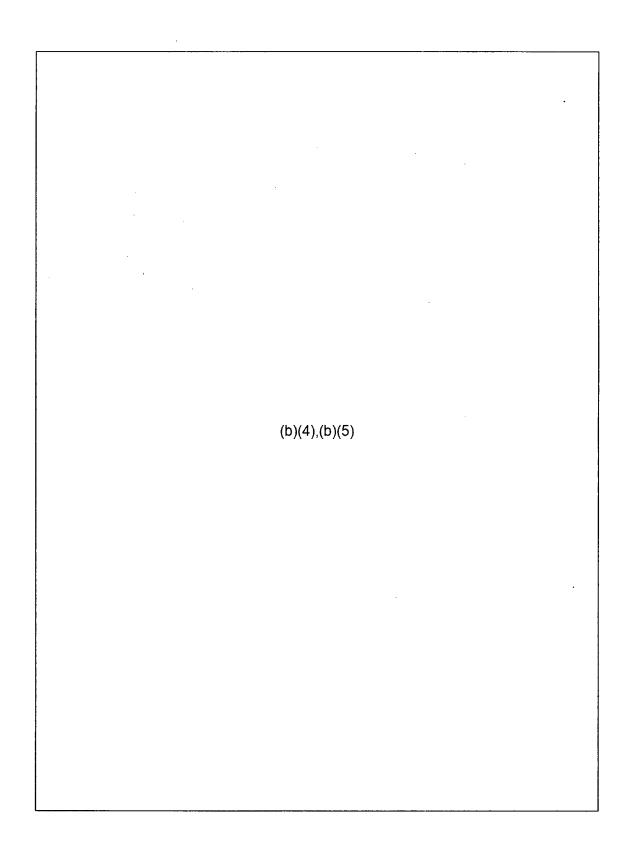
Thank you.

## SENSITIVE BUT UNCLASSIFIED



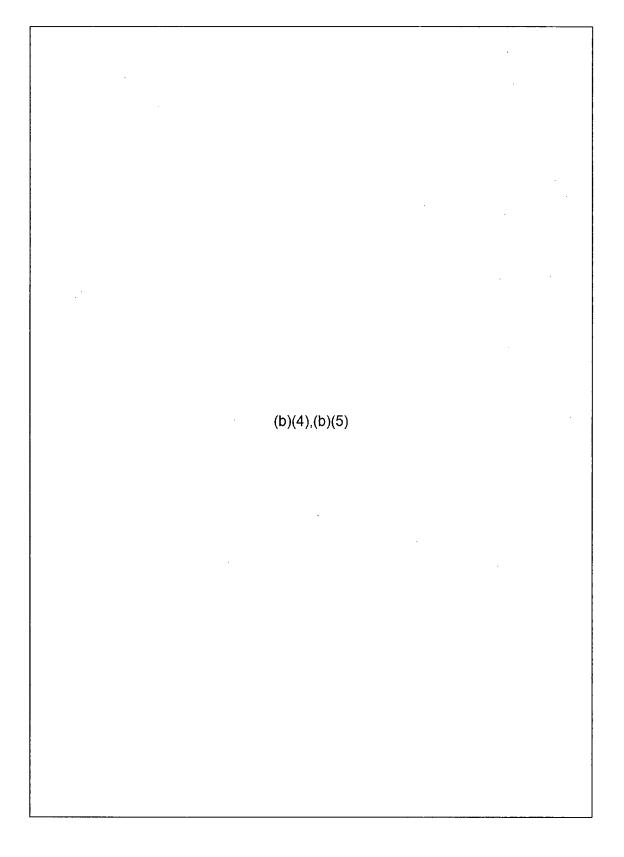
Tomorrow's meeting was set for 2000.

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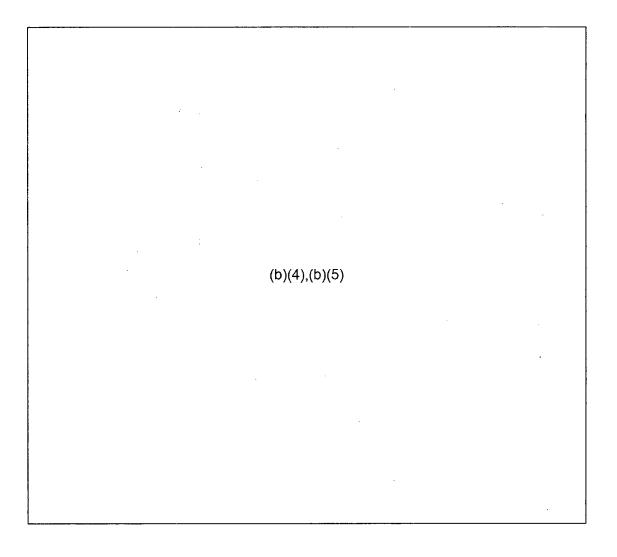


EY 58 of 942

# SENSITIVE BUT UNCLASSIFIED



EY 59 of 942



EY 60 of 942

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

#### - 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

Comments provided for Unit 1 apply to Units 2 and 3 also.

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## 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 (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<u>awater through</u> the feedwater system is cooling the vessel by hy in the feedwater system is cooling the vessel

(b)(4).(b)(5)	There is
likely no water level inside the core barrel. Natural circulation believed impe	
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.

## -- 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

	RECOMMENDATIONS:	
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1	(b)(4),(b)(5)	
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	<ul> <li>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</li></ul>	
	° (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
0430 EDT March 25, 2011
o (b)(4),(b)(5)
(b)(4).(b)(5) Containment spray should be secured before 2 psia. to

	(b)(4),(b)(5) Containment spray should be secured before 2 psial to prevent opening vacuum breakers.
0	(b)(4),(b)(5)
ο	When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)
	(b)(4),(b)(5)
Ens	<ul> <li>Borate water if possible. (With salt in vessels, consider effect of acidic condition in vessel when deciding how much boron to add.)</li> <li>sure SFP level maintained as full as possible</li> </ul>
ſ	
	(b)(4),(b)(5)

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

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

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#### - 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 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.

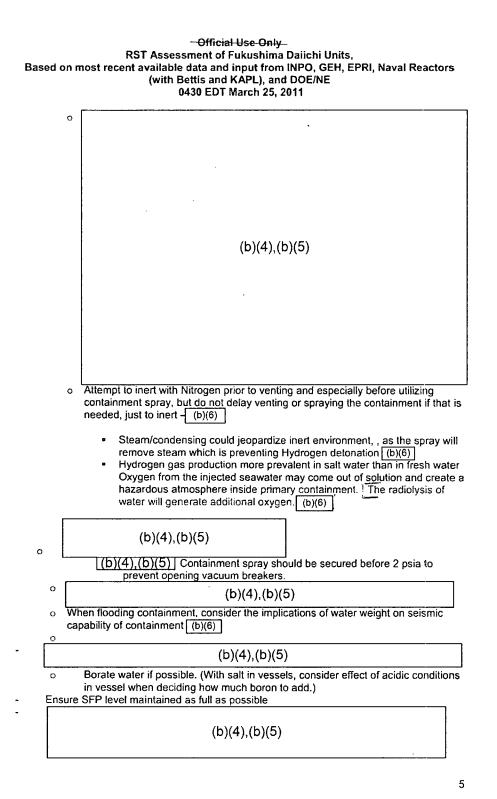
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel.

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:

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



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## - 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

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

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

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

EY 67 of 942

#### --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 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

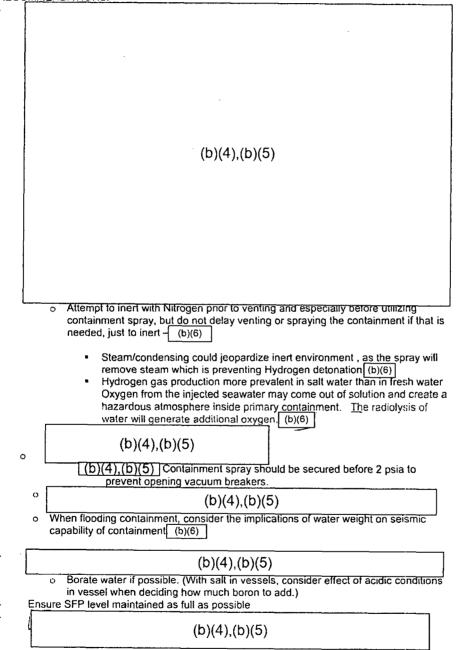
height, the reactor vessel water level is believed to be even with the level of the nan core recirculation pump seals, implying the seals have failed. While core flow capability may be affected due to continued salt build up, RPV water level indication is suspect due to environment. Natural circulation 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)

#### 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

**RECOMMENDATIONS:** 



## -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

0 (b)(4),(b)(5) o 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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#### ---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 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)
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 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

#### 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

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#### **RECOMMENDATIONS:**

- Monitor

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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: Sent: To: Cc: Attachments: ET05 Hoc Thursday, March 24, 2011 11:49 AM Sheron, Brian; Lee, Richard OST02 HOC; FOIA Response.hoc Resource 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.

### 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	Seawater injection, injecting through feedwater 119 l/min, or 300l/min, or
Cooling:	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 - (0)(4),(0) (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)	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 t	emperature
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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-	

UNIT TWO

STATUS: Core 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:

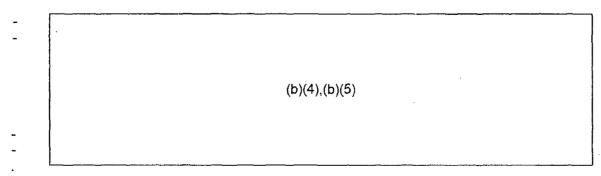
Damaged fuel may have fallen to		
the core is likely encased in salt	(b)(4),(b)(5	5)
mjecting seawater through the re-		
if any, flow past the fuel	(b)(4),(b)(5)	vessel, but with limited.
		]
	(b)(4),(b)(5)	
believed impeded by core damag	a It is difficult to data and	Natural circulation

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:**



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

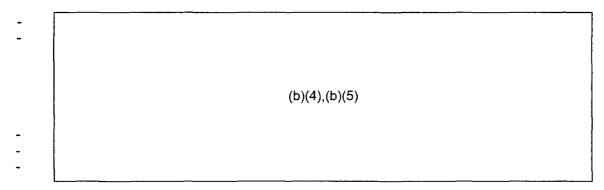
Damaged fuel may have fallen to the bo	ttom of the core and fuel in the lower region of
the core is likely encased in salt	(b)(4),(b)(5)
(b)(4),	
Injecting seawater through the recirculat	tion system is cooling the vessel, but with limited,
if any flow past the fuel	b)(4),(b) <del>(5)</del>
(b	)(4),(b)(5)
	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:**



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### UNIT FOUR

STATUS: Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
Core Cooling Primary: Containment	Not necessary (JAIF, NISA, TEPCO) 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)
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)

# 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: Core Cooling: Primary	In vessel (JAIF, NISA, TEPCO) Functional (JAIF, NISA, TEPCO) Functional (JAIF, NISA, TEPCO)
Containment:	
Secondary	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA,
Containment:	TEPCO)
Spent Fuel	Fuel pool cooling functioning (JAIF, NISA, TEPCO)
Pool:	
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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### **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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EY 81 of 942

### UNIT ONE

STATUS:

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

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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).

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

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

Secondary	Severely damaged (hydrogen explosion)
Containment:	

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

- 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:

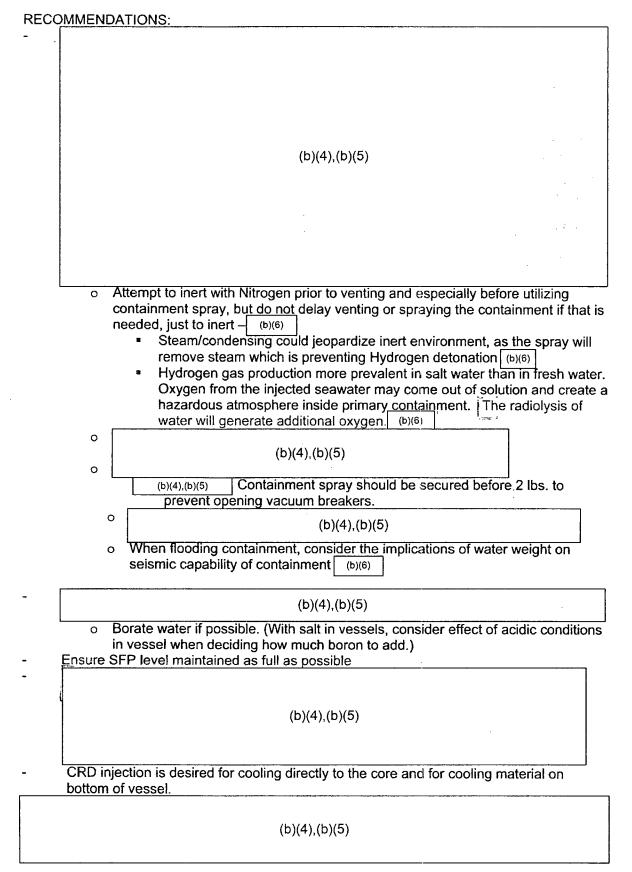
Damaged fuel that may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt and core flow is severely restricted and likely blocked. The core spray nozzles are likely salted up restricting core spray flow. Injecting segwater through the feedwater system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

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

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

The primary containment is not damaged.

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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)	
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)

b)(4) (b)(5) Based on the reports of RV level at one half core Based on the reports of RV level at one half core Based on the reports of RV level at one half core Based on the reports of RV level at one half core 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)
C	Attempt to inert with Nitrogen prior to venting and especially before utilizing containment spray, but <u>do not</u> delay venting or spraying the containment if the needed, just to inert - (b)(6)
	<ul> <li>Steam/condensing could jeopardize inert environment, , as the spray remove steam which is preventing Hydrogen detonation (b)(6)</li> <li>Hydrogen gas production more prevalent in salt water than in fresh wa Oxygen from the injected seawater may come out of <u>sol</u>ution and creat hazardous atmosphere inside primary <u>containment</u>. (The radiolysis of water will generate additional oxygen. (b)(6)</li> </ul>
0   0	(b)(4),(b)(5)
L	(b)(4),(b)(5) Containment spray should be secured before 2 lbs. to prevent opening vacuum breakers.
0	
0	seismic capability of containment (b)(6)
	(b)(4),(b)(5)
i	Borate water if possible. (With salt in vessels, consider effect of acidic conditi in vessel when deciding how much boron to add.) SFP level maintained as full as possible
	(b)(4),(b)(5)

bottom of vessel.

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

EY 86 of 942

### 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:

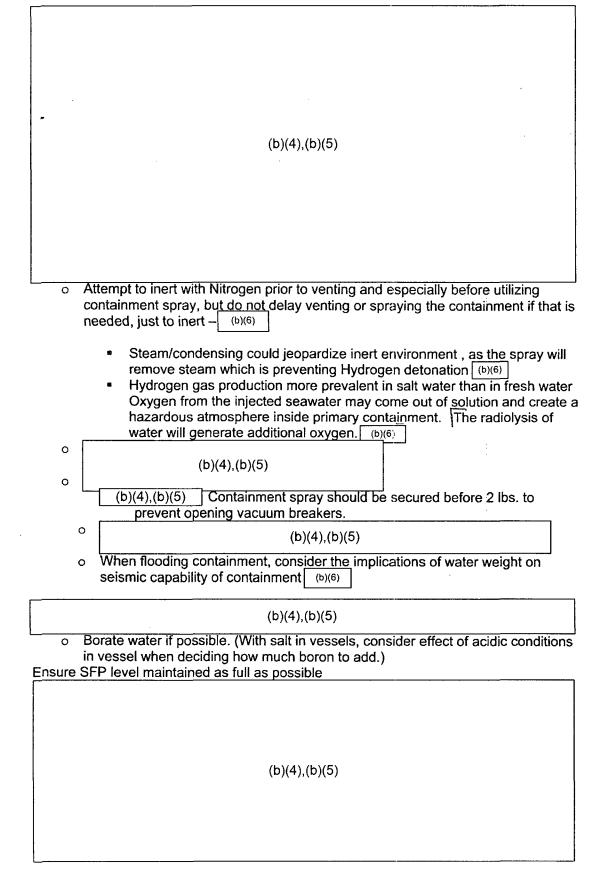
Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

	ater through the RHR system is cooling the vessel, but with limited, flow
past the fuel.	(h)(4) (h)(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)



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

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

### **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: Rad Levels:	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
Nau 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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### **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

# 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

EY 93 of 942

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From: Sent: To: Subject: Attachments:

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OST01 HOC Thursday, March 24, 2011 4:01 AM Virgilio, Martin: McGinty, Tim; Boger, Bruce; ET07 Hoc FW: RST draft assessment for review 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

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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

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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

EY 94 of 942

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#### -<del>0U0</del>-

### 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)

EY 95 of 942

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#### 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

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

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### RST Assessment of Fukushima Dailchi 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)

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#### 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
То:	(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: Sent: To: Subject: Attachments: Powell, Amy Thursday, April 07, 2011 2:58 PM Batkin, Joshua FW: RST Assessemnts 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)

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.

EY 101 of 942

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

EY 102 of 942

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Based on most re	cent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE	
	06004400 EDT March 25 <u>6</u> , 2011	Formatted: Font: 8 pt
The non-tase of the deciment is to create the NRC Relator Safety. Tean's assessment and recommendations, by the Euclidiana Derich readers to the USRC team in Japan. Our assussments and recommendations are based on the best reveloble technical information. We acknowledge that the information is subject to change and reference).		Formatted: Normal,NRC
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UNIT ONE		Formatted: Top: 1.25", Bottom: 0.88"
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 en-3/24) <u>Drywell and</u> 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)	
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]	
ASSESSMEN	T:	
Damaged fuel	that may have slumped to the bottom of the core and fuel in the lower region of	

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EY 103 of 942

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 impeging any flow past the fuel.

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	(b)(4),(b)(5)	There is
	likely no water level inside the core barrel. Natural circulation believed impeded by co	ore

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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<u>Official Use Only</u> RST Assessment of Fukushima Dailchi Units, sed on most recent available data and input from INPO, GEH, EPRI. Naval Reactors (with Bettis and KAPL), and DOE/NE 060014409 EDT March 25 <u>8</u> , 2011	Formatted: Font: 8 pt
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curpose of this documentus to provide the NRC Boactor Safety Toam's assessment and recommendations for the Eukuchma- col reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical mation. We assessfuldge that the informatice is subject to change and reflectment.	
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The purpose of this document is to provide the NRC Reputor Solidy Team's assessment and recommendations for the missioning. Oxidati manifors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical	Formatted: Normal,NRC
information. We acknowledge that the information is subject to change and refinement.	· · · · · · · · · · · · · · · · · · ·
<ul> <li>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)]?</li> <li>Steam/condensing could jeopardize inert environment, as the spray will</li> </ul>	Formatted: Font: 8 pt
<ul> <li>remove steam which is preventing Hydrogen detonation (b)(6)</li> <li>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)</li> </ul>	· :
(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)	
<ul> <li>When flooding containment, consider the implications of water weight on seismic capability of containment (b)(6)</li> </ul>	
- (b)(4),(b)(5)	
<ul> <li>Borate water if possible. (With salt in vessels, consider effect of acidic conditions in vessel when deciding how much boron to add.)</li> <li>Ensure SFP level maintained as full as possible</li> </ul>	
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- CRD injection is desired for cooling directly to the core and for cooling material on bottom of vessel.	•
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EY 105 of 942

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Official Use Only- RST Assessment of Fukushima Daiichl Units, Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE <u>0600</u> 4449 EDT March 25 <u>6</u> , 2011		
The purcesse of the document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushina- Dation reactors to the USNRC team or Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and reangment.		
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 bor c 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) )900 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) Weater 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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Based on most recent available data and input from INPO, GEH, EPRI, Navai Reactors (with Bettis and KAPL), and DOE/NE
<u>0600</u> 440 <del>0</del> EDT March 25 <u>6</u> , 2011
<ul> <li>The purpose of this document is to provide the NRC Reactor Safety Tenai's assessment and incommendations for the Fukushina-</li> </ul>
Deach: reactors to the USNRC team in Japan Our assessments and recommendators are based on the best available reconcel
informationWe acknowledge that the information is subject to change and refinement.

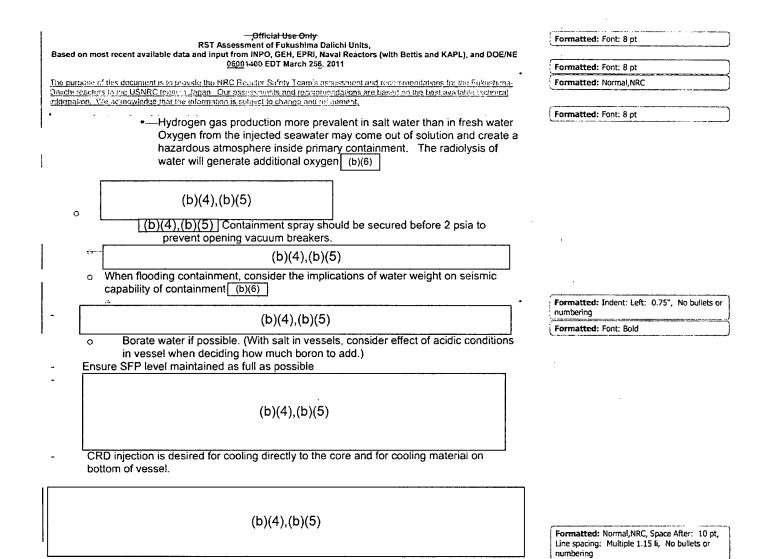
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Fuel pool is heating up but is adequately cooled.

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# RECOMMENDATIONS:

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	(b)(4),(b)(5)	
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	<ul> <li>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)</li> <li>Steam/condensing could jeopardize inert environment, , as the spray will remove steam which is preventing Hydrogen detonation (b)(6)</li> </ul>	Formatted: Bulleted + Level: 2 + Aligned at: 0.75" + Indent at: 1"



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<del>Official Use Only_</del> 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 <u>0600</u> 4400 EDT March 25 <u>6</u> , 2011					
Dai chi reactors to the USNRO	The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Eukustrima- Dai chi 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)				
	(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) <del>0900 3/25/11 Call source</del> instruments-unknown <u>industry</u> ); Outside plant: 26mR/hr at gate (variable) ((b)(6) <del>1990 hrs 3/25/11 <u>Industry</u>);</del> 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) www.ater 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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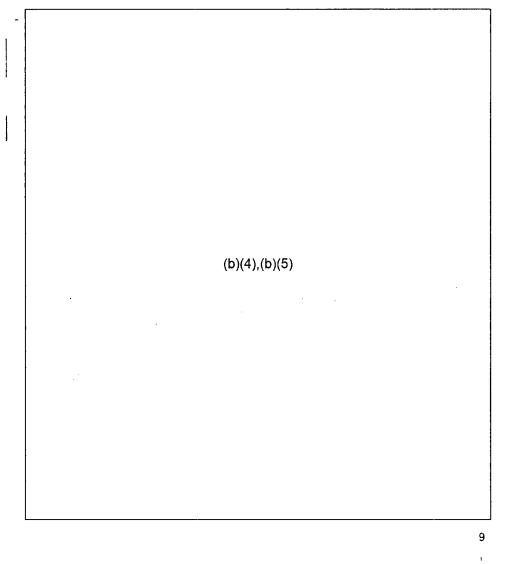
#### ---<u>Official Use Only-</u> RST Assessment of Fukushima Dalichi Units, Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE <u>0600</u>1480 EDT March 25<u>8</u>, 2011

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and reporting dations for the Eukostana-Datchi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available techo cal information. We assessment and references

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(6)(4), b(5)Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire

valves, Rx building sump drains) were identified, however the likely source is the firm water spray onto the reactor building. Additional evaluation is needed.

### **RECOMMENDATIONS:**

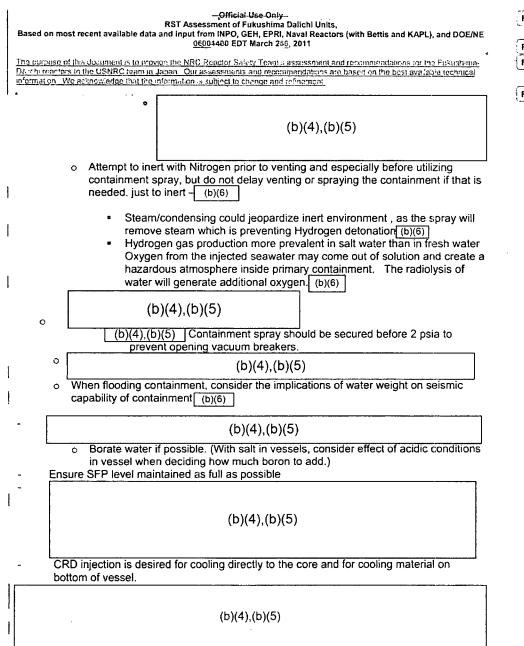


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-Official Use Only RST Assessment of Fukushima Dailchi Units, Based on most recent available data and Input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE <u>0600</u>3400 EDT March 256, 2011

Lie purpose of this document is to provide the NEC Reactor Safety, I cam's assessment and recommondations for the Excusional Databa reactors to the USNRC togan in Jouan Our assessments and recommendations are based on the best available technical manuation. We acknowledge that the information is subject to change and relinging

# UNIT FOUR

	STATUS: Core Status:	Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)
	Core Cooling	Not necessary (JAIF, NISA, TEPCO)
ļ	Primary: Containment	Not applicable (JAIF, NISA, TEPCO)
	Secondary: Containment:	Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)
1	Spent Fuel Pool:	Low water level, spraying with sea water, hydrogen from the fuel pool exploded, fuel pool is cool heating <u>up very slowly (JAIF, NISA, TEPCO)</u> Temperature is unknown (NISA) (b)(4),(b)(5)
	Rad Levels:	3/24
ł	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 buildozed 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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--Official Use Only-RST Assessment of Fukushima Dailchi Units, Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE 06001460 EDT March 25<u>6</u>, 2011

Incrustroade of this document is to provide the NRC Reader Safety Team's assessment and recommendations for the Eukush ma-Datch, reactors to the USNKC team in Japan. Our assessments and recommondations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

## 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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# EY 114 of 942

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

The purpose of this document is to provide the NBC Reactor Sarety Leaves assassment and recommendations for the Fukusrima-Dation is where to the USNRC treem in Jacob, Our assessments and recommendations are based on the best wedable technical information. We asknowledge that the information is subject to change and refinement.

# 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

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-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 06001400 EDT March 25<u>6</u>, 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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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: Flag Status:	Follow up Flagged		

#### Authorization for Limited Distribution of Restricted Documents

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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

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### DISCLARER

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### Official Use Only. 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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### -Official Use Only-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 Sprav 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 sca 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

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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 an	d oxygen concentrations
are unknown.	
(b)(4),(b)(5)	
The status of the nitrogen purge capab	oility is unknown.
	Ап

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:

### -Official-Use-Only-

### 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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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 by jupited if any flow past the fuel.

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.

# EY 121 of 942

### -Official Use Only-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.

**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)
6	Vent containment (b)(4),(b)(5) (See Additional
	Considerations A.1. through A.5 below)
	<ul> <li>a. To maintain containment pressure below the primary containment pressure limit.</li> <li>b. As necessary to maintain RPV injection above MDRIR.</li> </ul>
	(b)(4),(b)(5)
7	
Þ	

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**

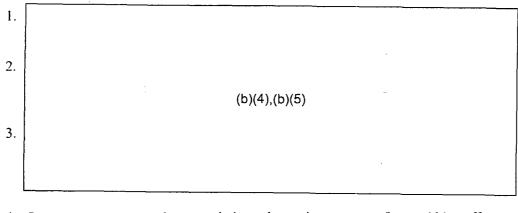
A. The following considerations apply to containment venting:

### -Official Use Only-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

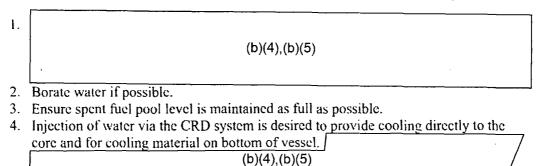
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- 4. Spray water on steam plumes and planned containment vents for scrubbing effect and
  - (b)(4),(b)(5)

# B. Additional Miscellaneous considerations



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

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

#### 2200 hrs 3/30/2011

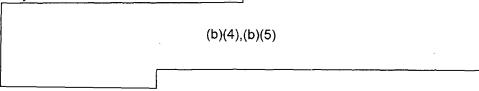
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4.		
	(b)(4),(b)(5)	
5.		

# 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).



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

Page 7

EY 124 of 942

### -Official Use Only-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.

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	

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

Page 8

### -Officia<del>l Use Only</del> 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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# 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)	
۶		
¥		
	(b)(4) (b)(5)	
	(b)(4),(b)(5)	
2		
		1

- 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)

### -Official Use Only 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

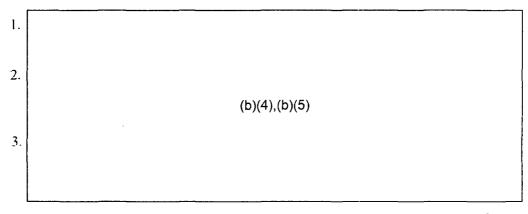
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	(h)(d)(h)(c)
dl	(b)(4),(b)(5)
u	

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:



- 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)

EY 127 of 942

### - Official Use Only-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.

a.	(b)(4),(b)(5) HPC	I (b)(4),(b)(5) uction pressure and Drywell
	instrument taps	
b.	Radiation monitoring instruments	(b)(4),(b)(5)
C.		
d.	(b)	4),(b)(5)
c.		

### **UNIT THREE**

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

Core Status:	Majority of core is probabl	y contained in reactor vessel;	(b)(4),(b)(5)	-
		TEPCO believes the reacto	r 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.

Page 11

EY 128 of 942

### - Official Use Only -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.

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.

### <u>Official Use Only</u> 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 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.

۶	Inject into the RPV with all availa	ble resources	
	a. core spray	(b)(4),(b)(5)	$\backslash$
	b. feedwater system		
	c. <u>other systems as they beec</u> 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.

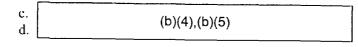
b. As necessary to maintain RPV injection above MDRIR.

Page 13

### <u>Official Use Only</u> 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

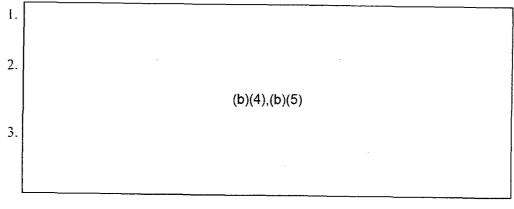
The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject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



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:



- 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.

### Official Use Only 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.

C. Potent	ial methods for monitoring containment level. (b)(4),(b)(5) \ HPCI	suction pressure and Drywell	
b.	instrument taps 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

Page 15

EY 132 of 942

### -Official Use Only 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.

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, & GEII)

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

Core Cooling: Functional (JAJF, 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.

Page 16

EY 133 of 942

### -Official Use Only 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.

Monitor

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### -Official Use Only-

### 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 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

Page 18

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

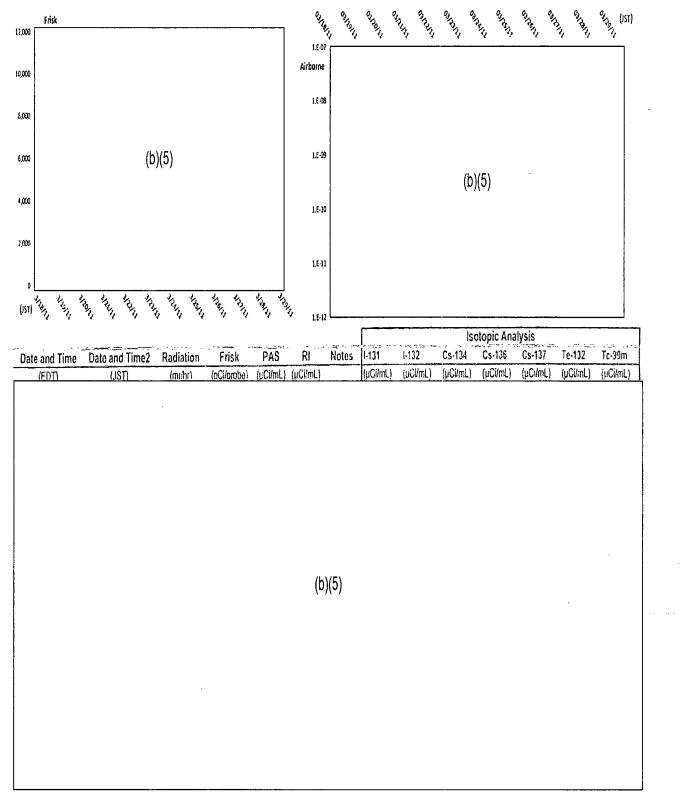
From: NITOPS[SMTP:NITOPS@NNSA.DOE.GOV] Sent: Sunday, March 27, 2011 1:50:06 PM To: DL-Policy Working Group; CMHT; HOO Hoc; NARAC; PMT01 Hoc; PMT02 Hoc; Hoc, PMT12 Cc: NITOPS Subject: FW: Japan Radiological Data Auto forwarded by a Rule

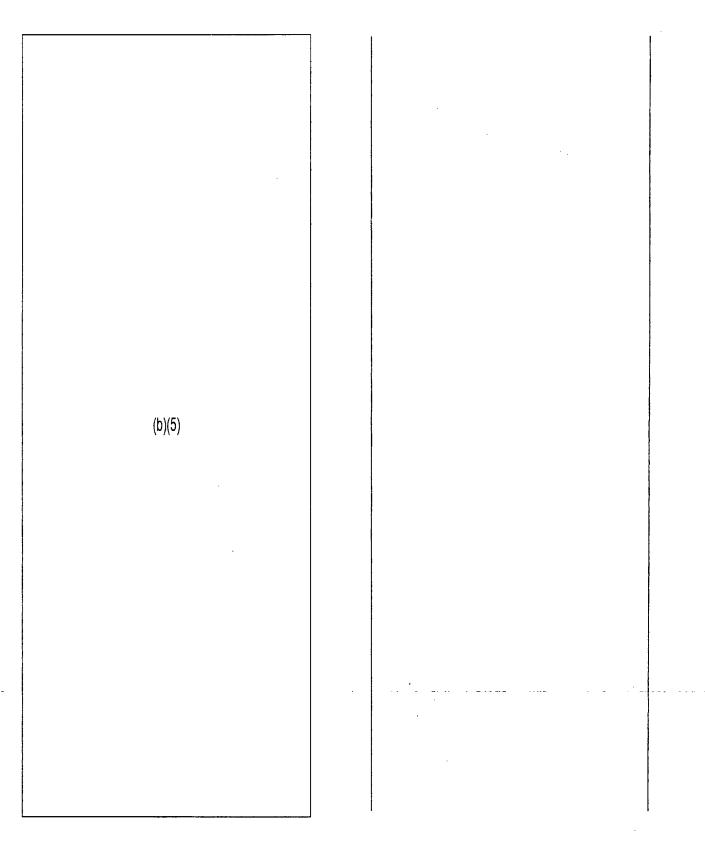
Original Message		
From: Naples, Elmer M SES SEA 08 NR (mailto	(b)(6)	
Sent: Sunday, March 27, 2011 1:45 PM		
То:		
	(b)(6)	

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.

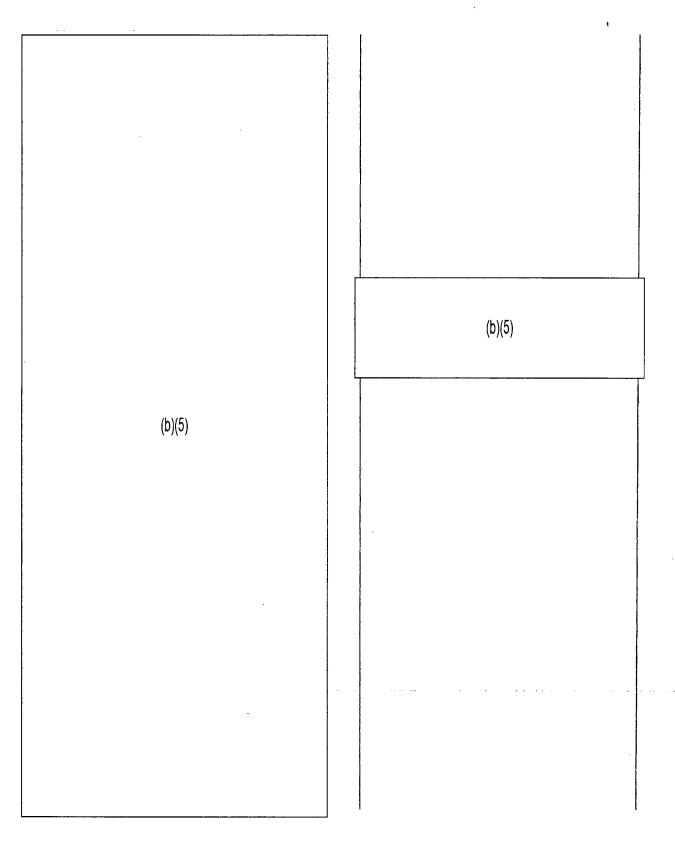
V/R, Elmer Naples Naval Reactors Nanaban Tower: LAT. 35.29N, LONG. 139.67E Yokosuka

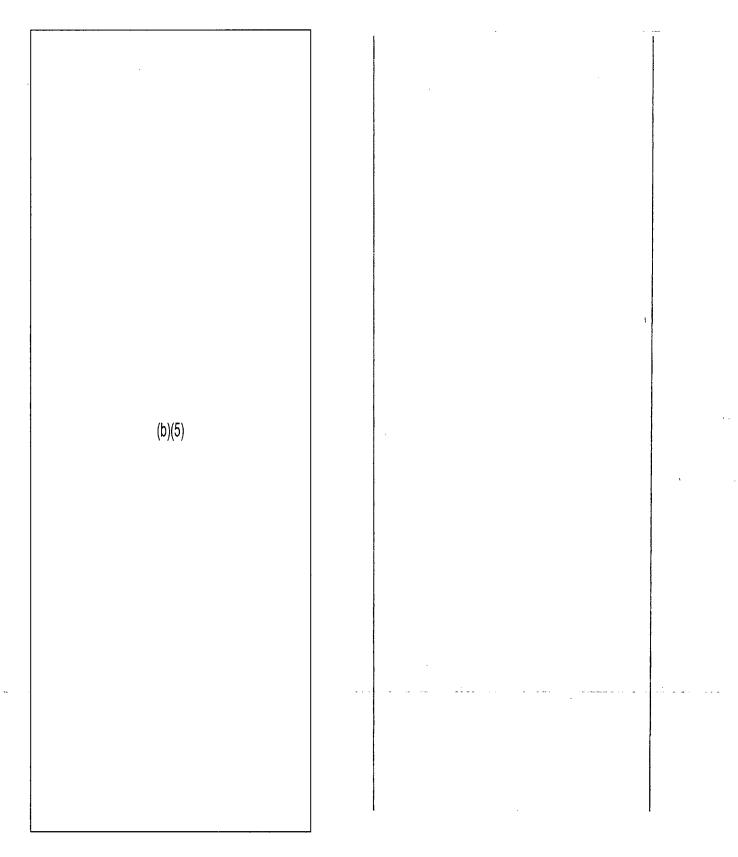




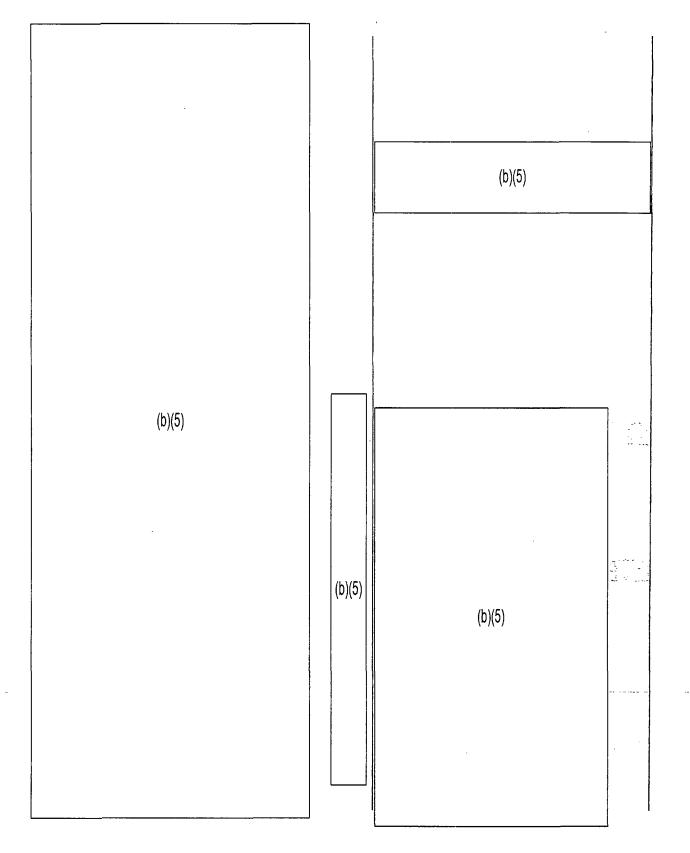
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EY 138 of 942



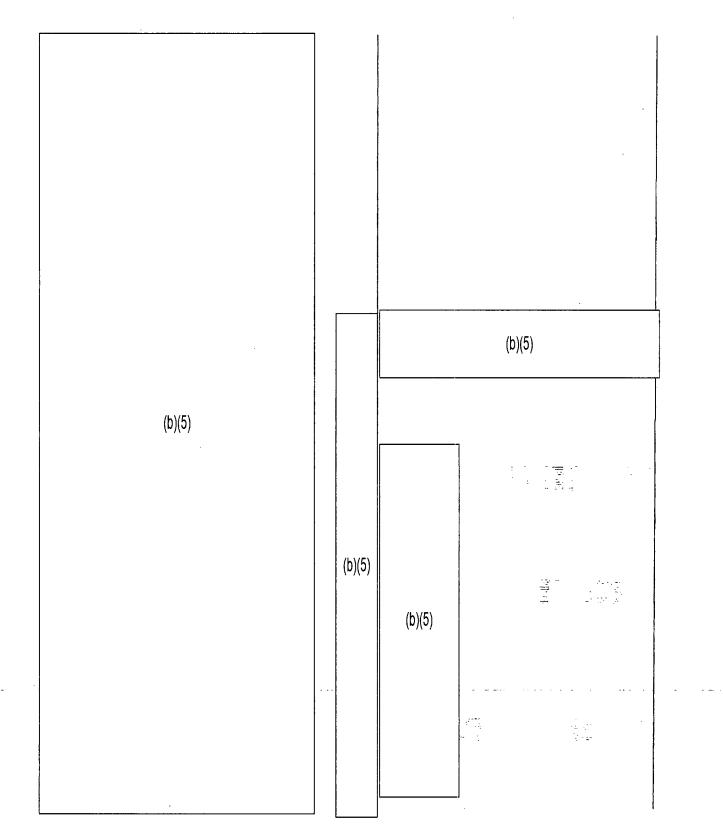


EY 140 of 942



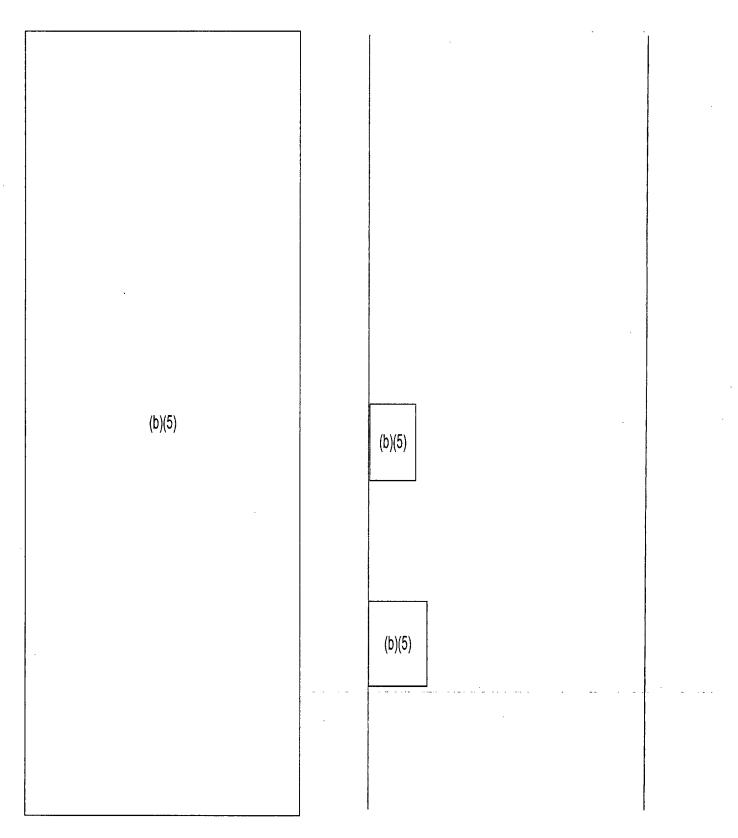
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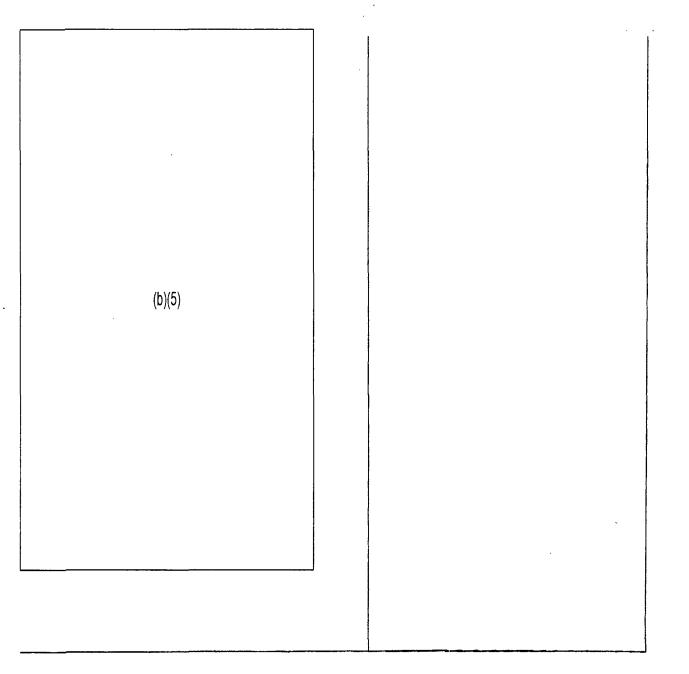
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EY 142 of 942





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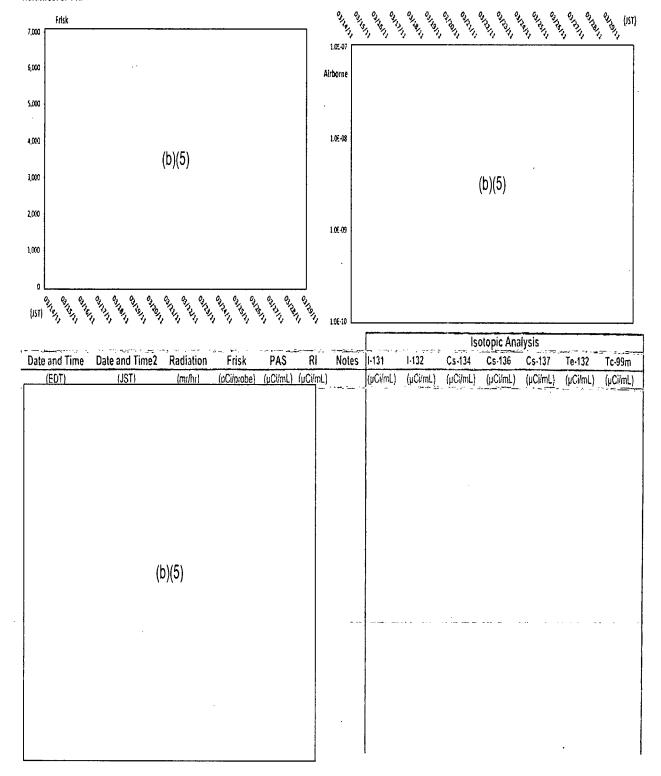
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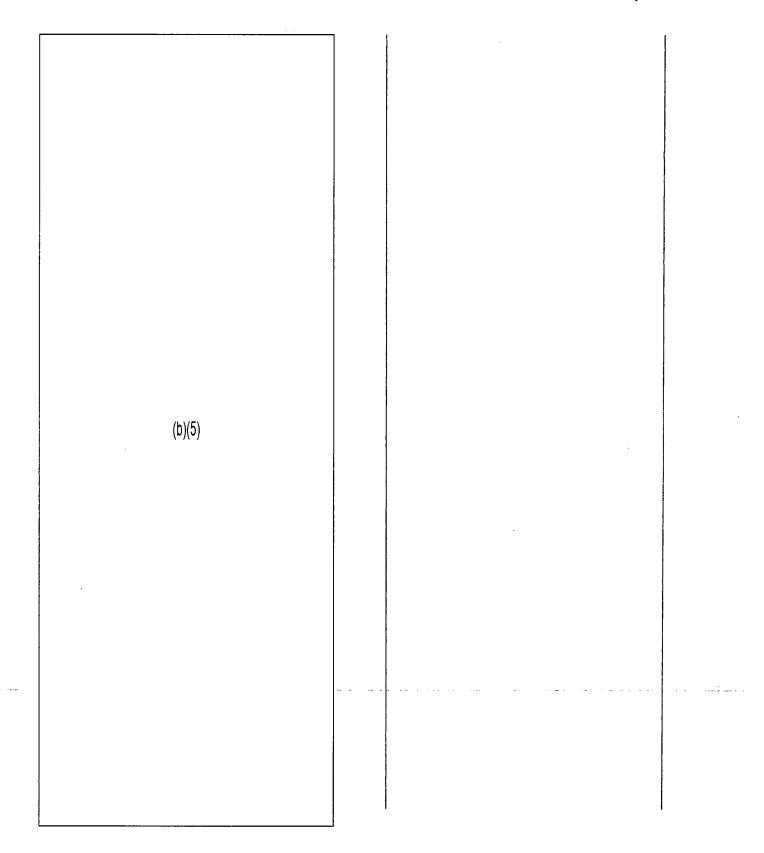
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EY 144 of 942

#### Atsugi NAS: LAT 35.42N, LONG. 139.36E Northwest of Yokosuka

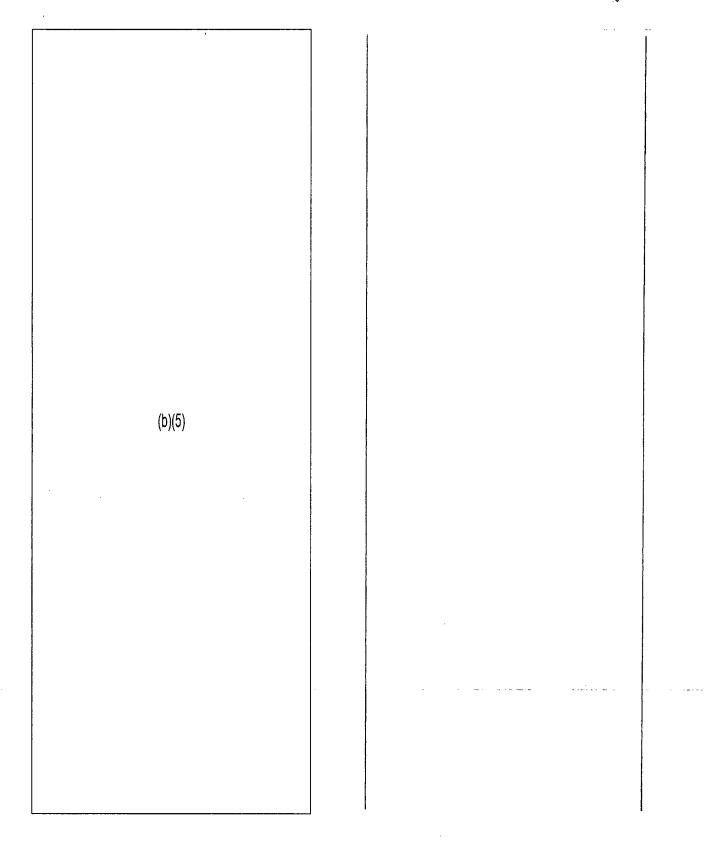


EY 145 of 942

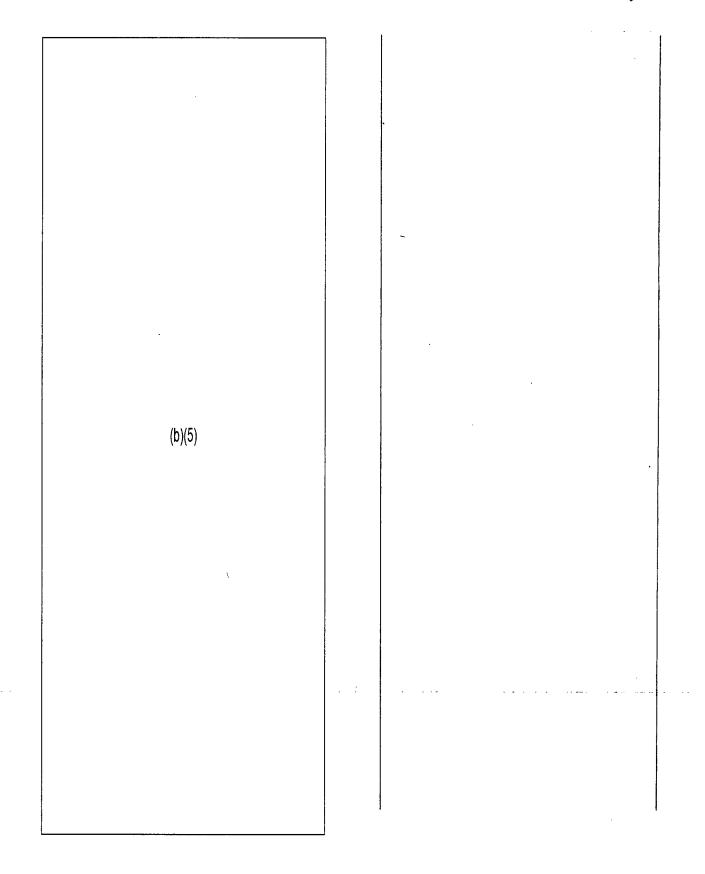


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# Atsugi - 11 of 37



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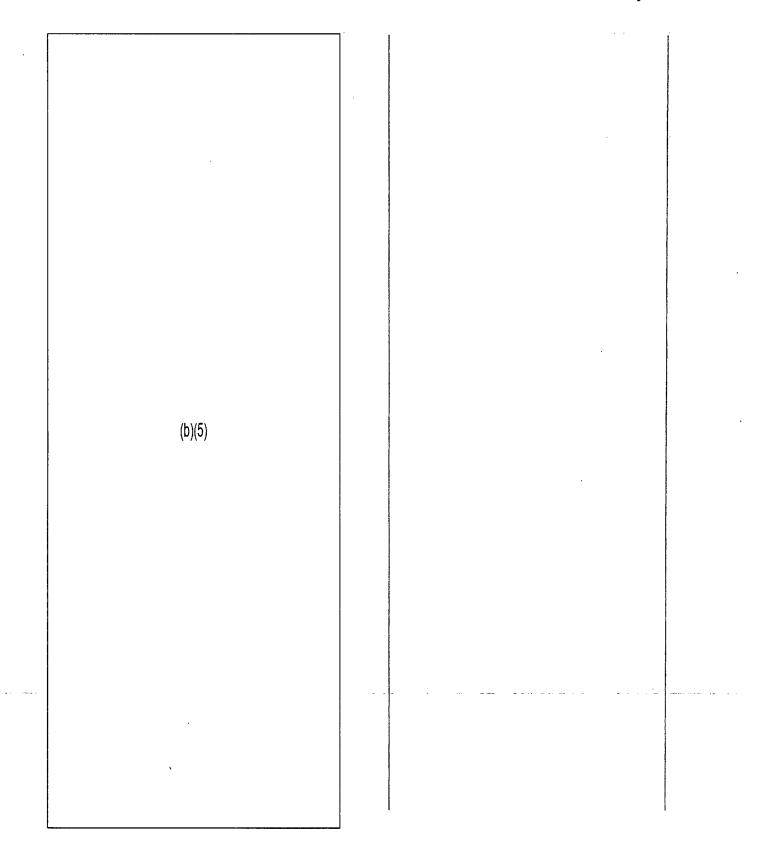
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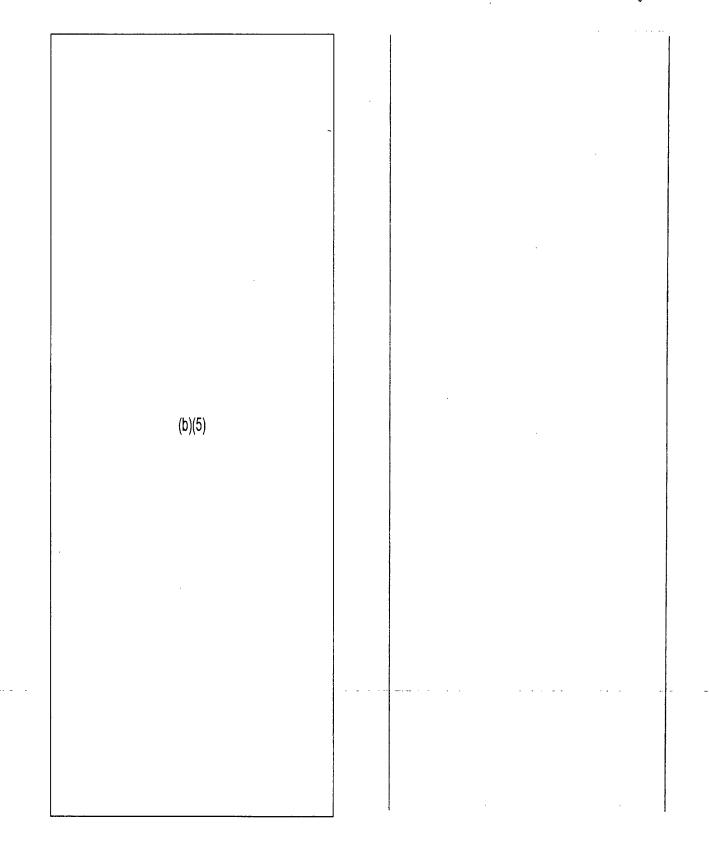
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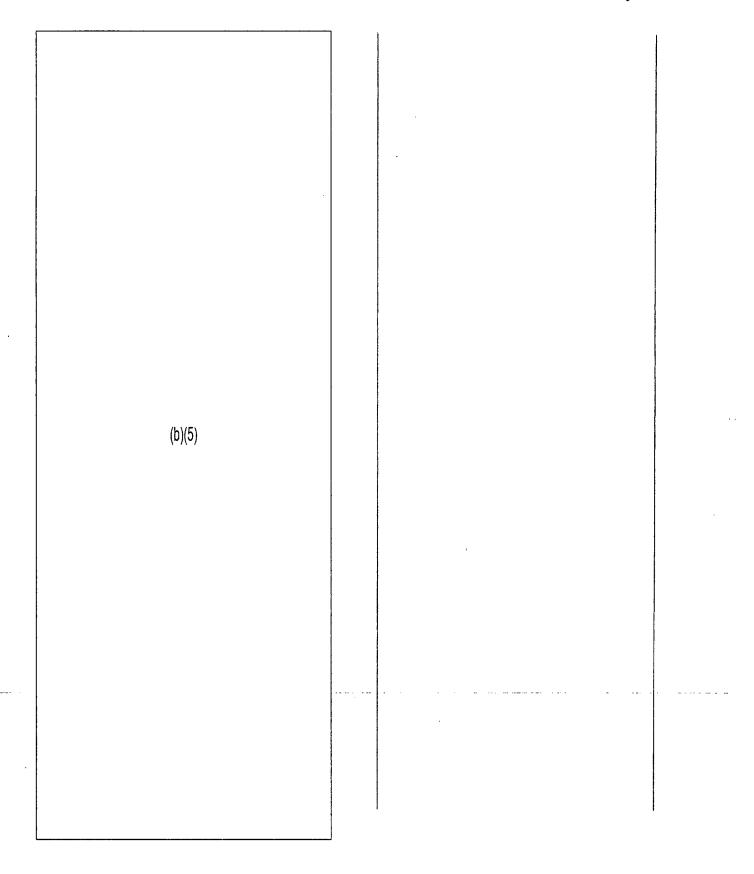


### Atsugi - 14 of 37

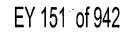


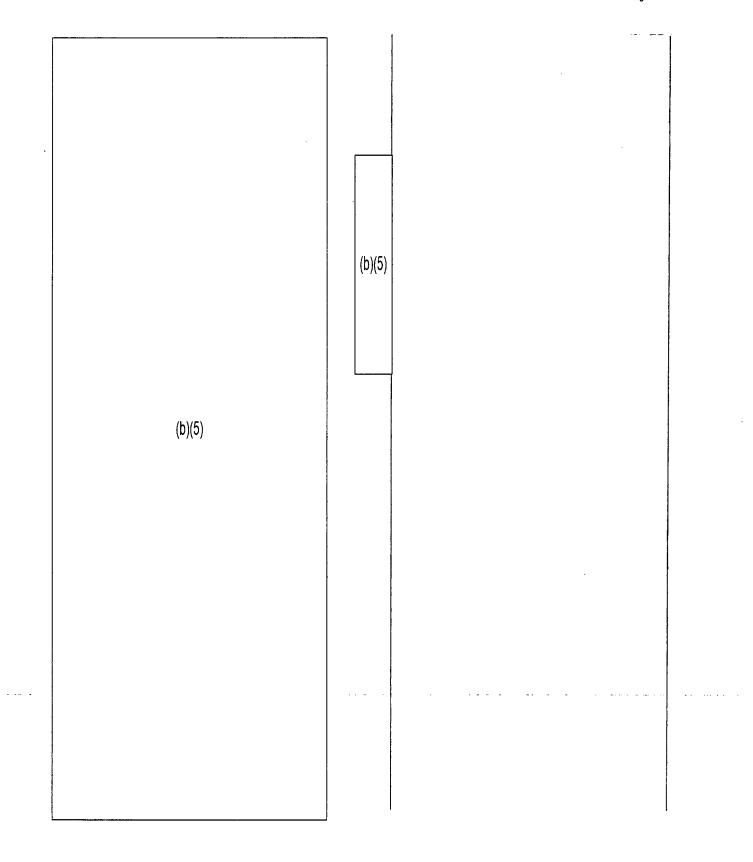
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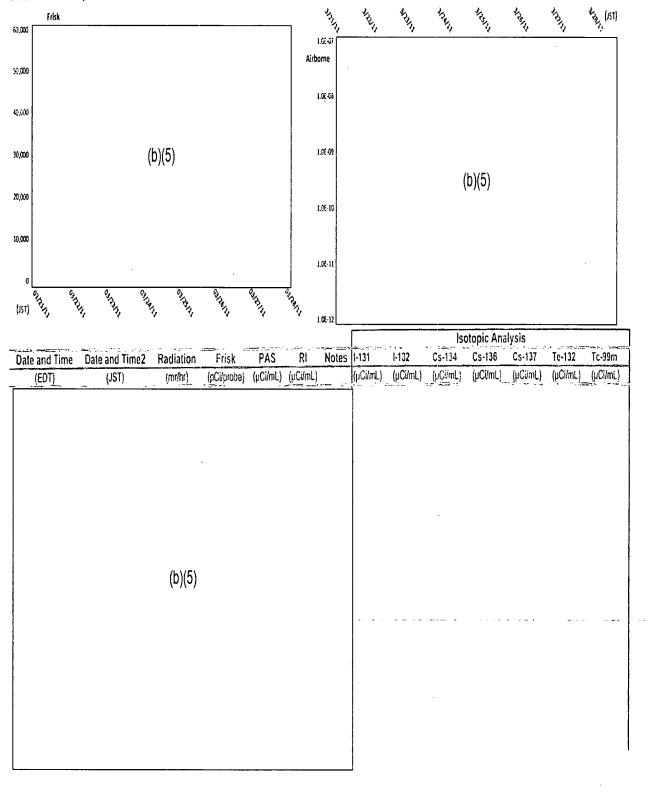
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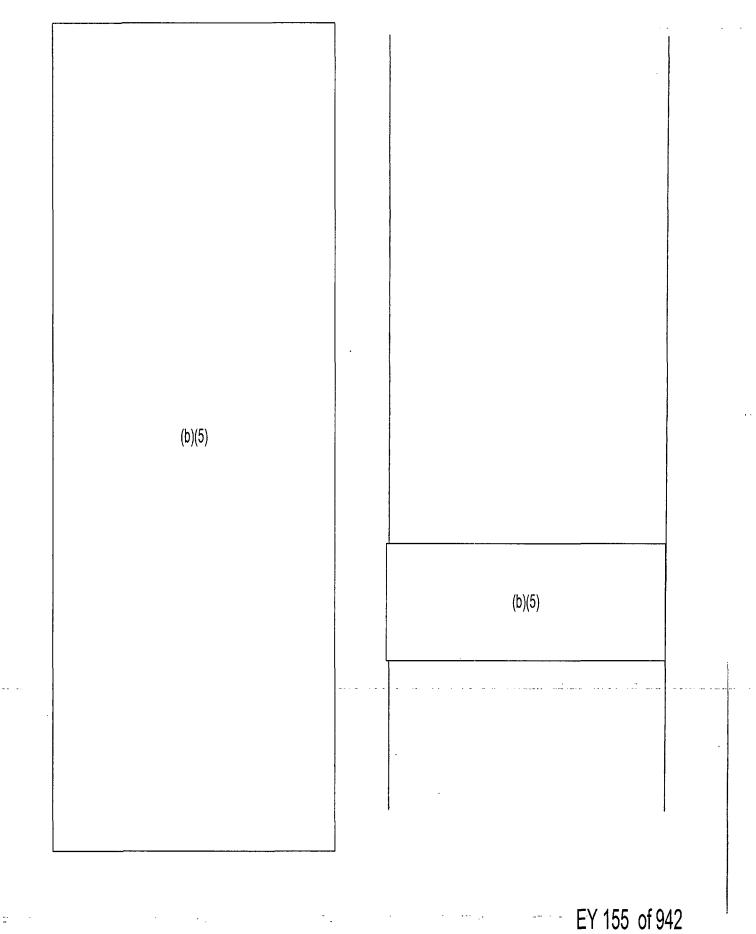
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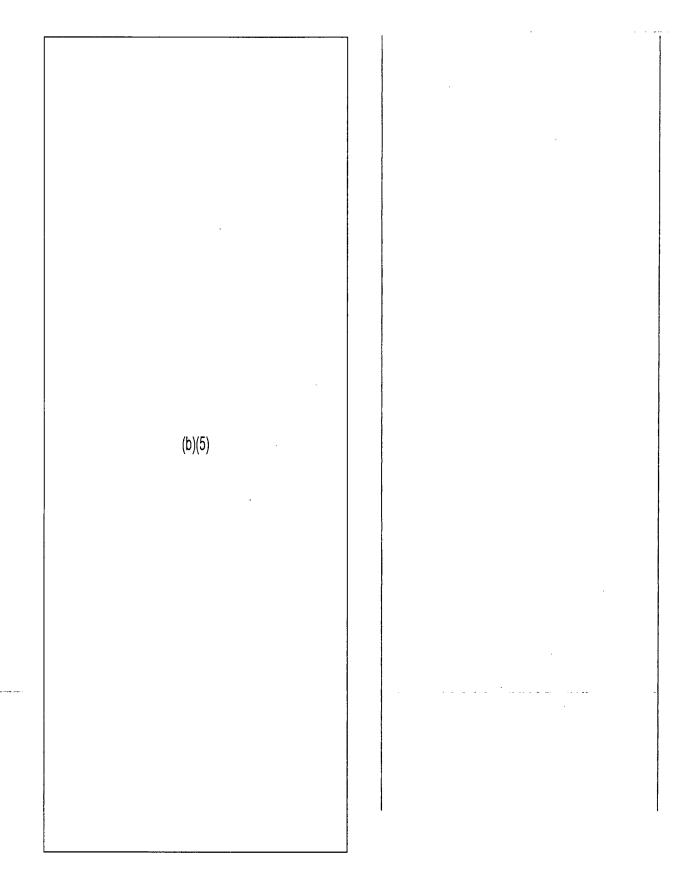
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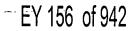
Ishioka (North Advance Team): LAT. 36.18N, LONG. 140.27E 55nm N of Yokosuka, 93nm S of Fukushima



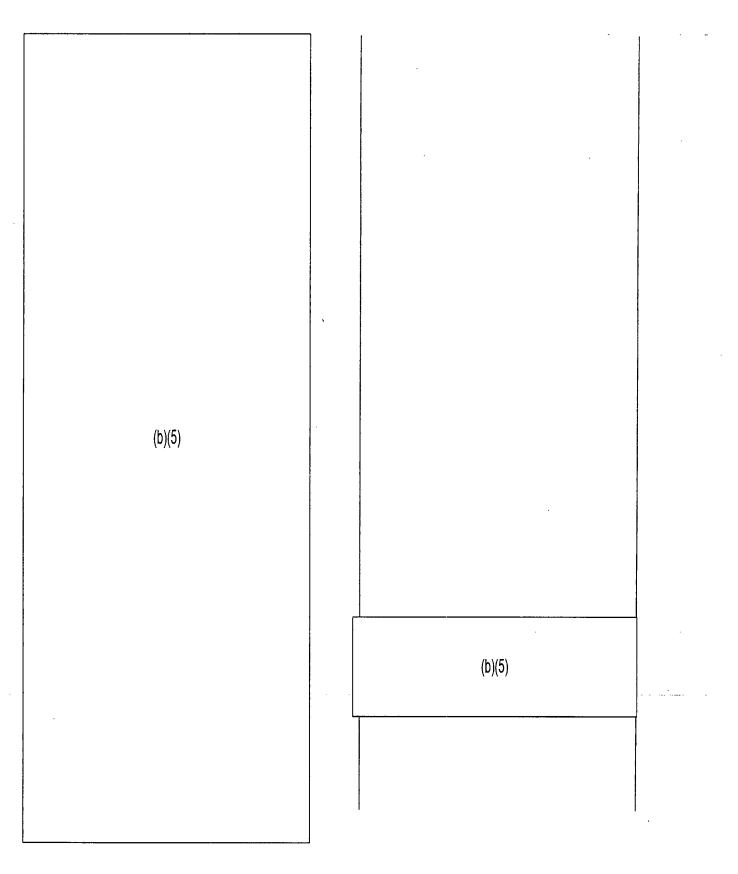
EY 154 of 942





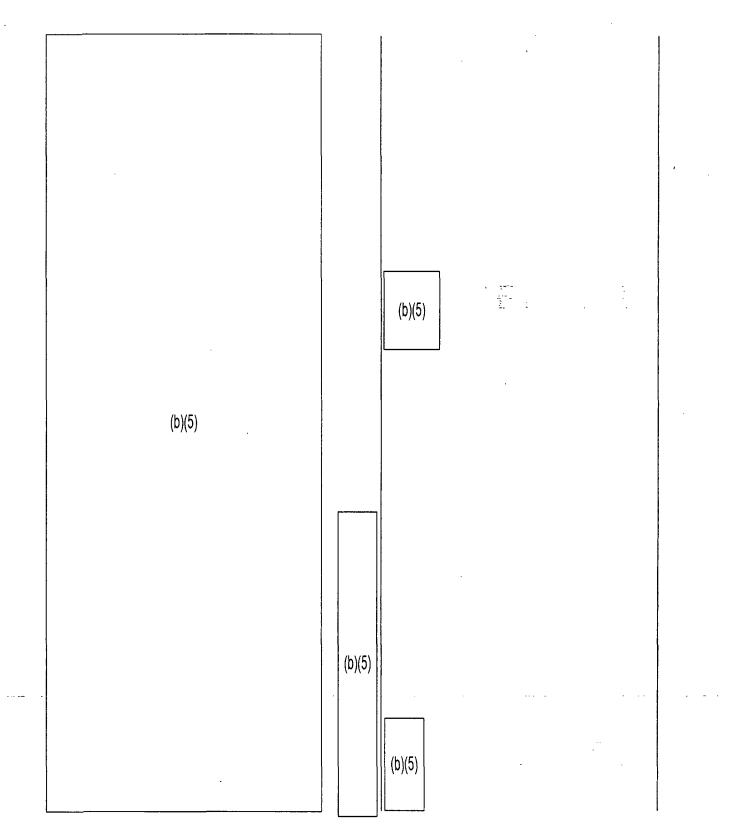


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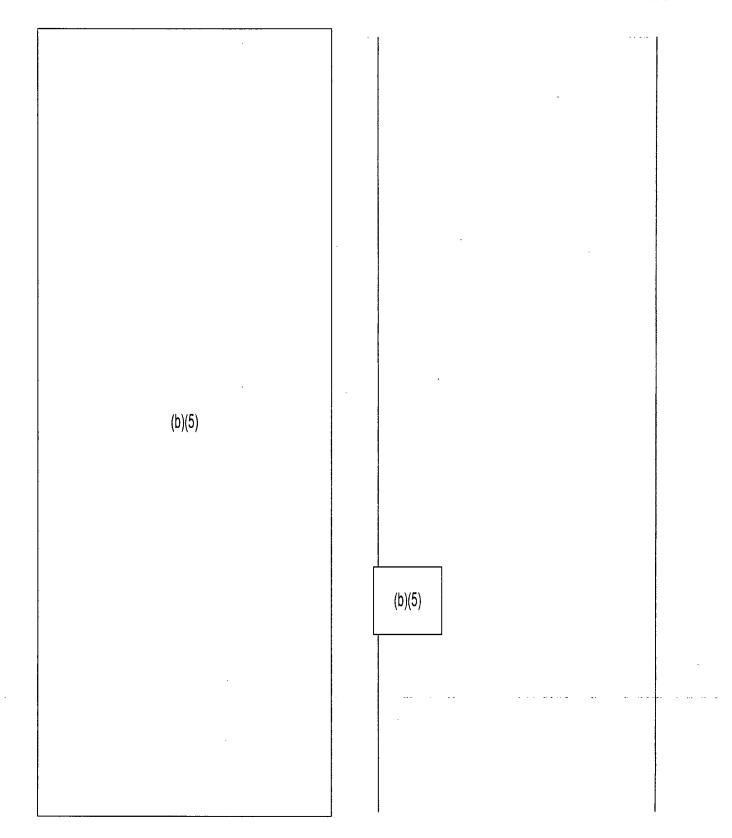


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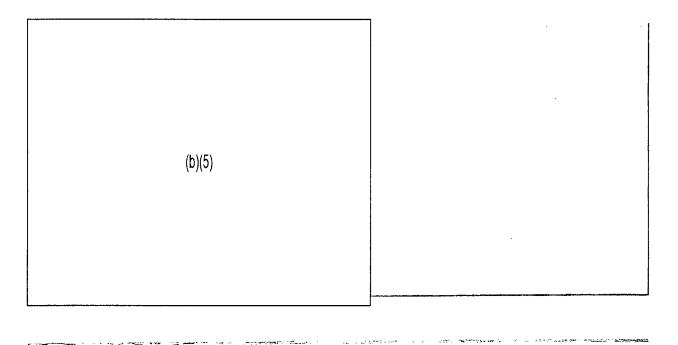
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EY 158 of 942



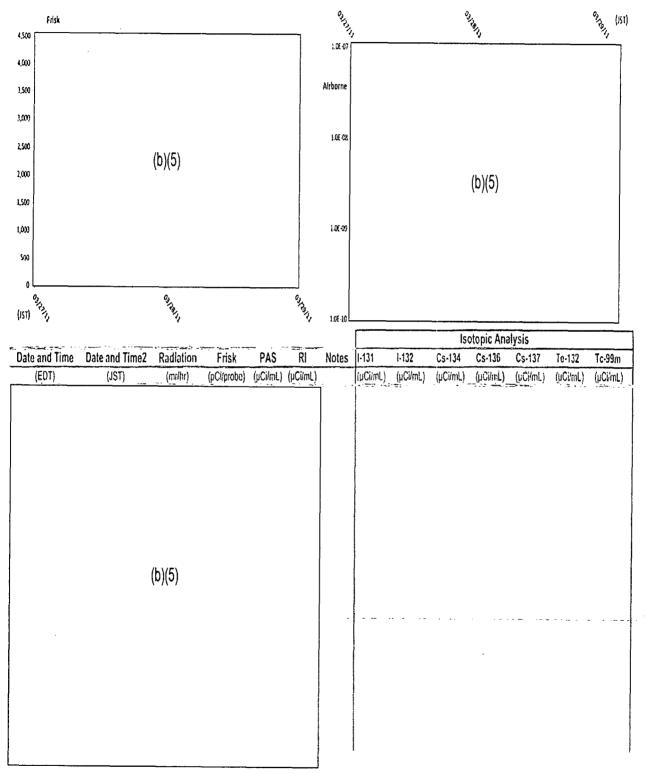
EY 159 of 942



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EY 160 of 942



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

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EY 161 of 942

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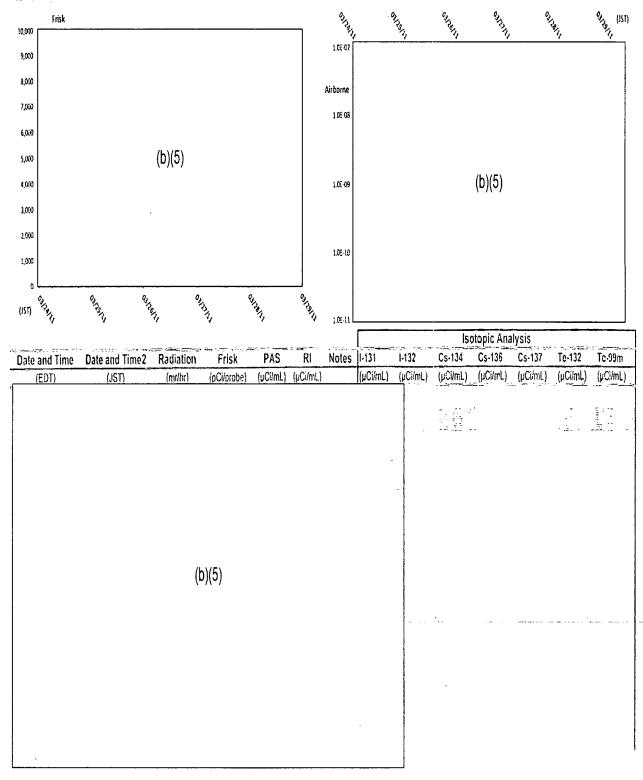
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EY 162 of 942

## Tsukuba: LAT. 36.04N, LONG. 140.06E

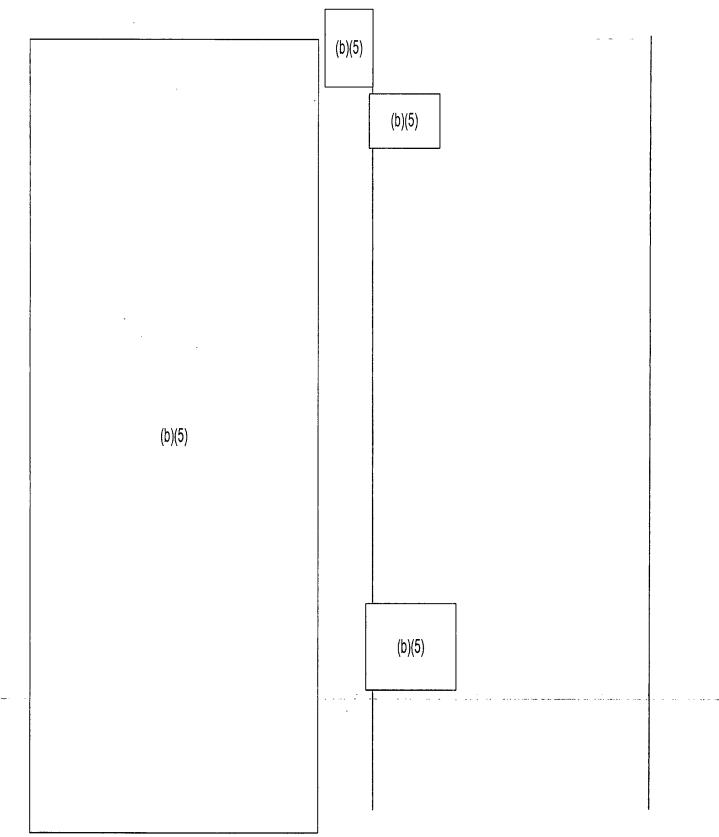
~60 miles north-east of Yokosha and 106 miles south of Fukushima



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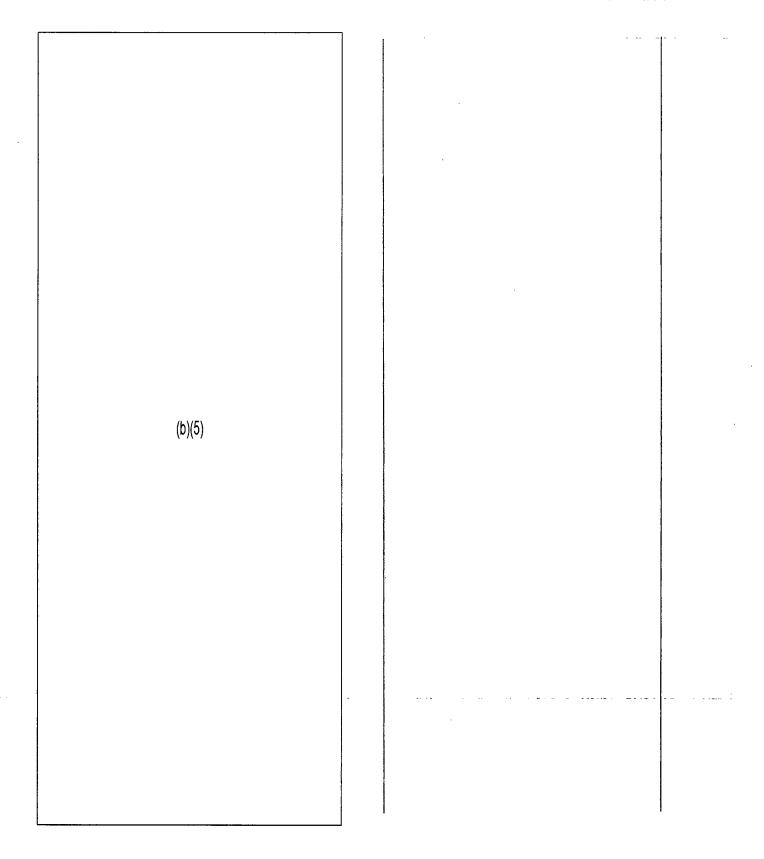
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EY 163 of 942



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EY 164 of 942



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EY 165 of 942

#### Tsukuba - 30 of 37

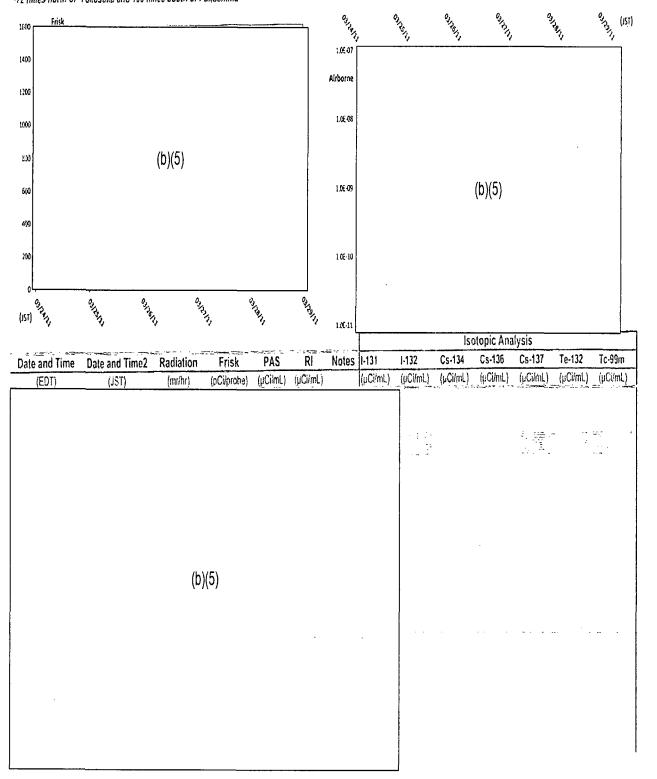
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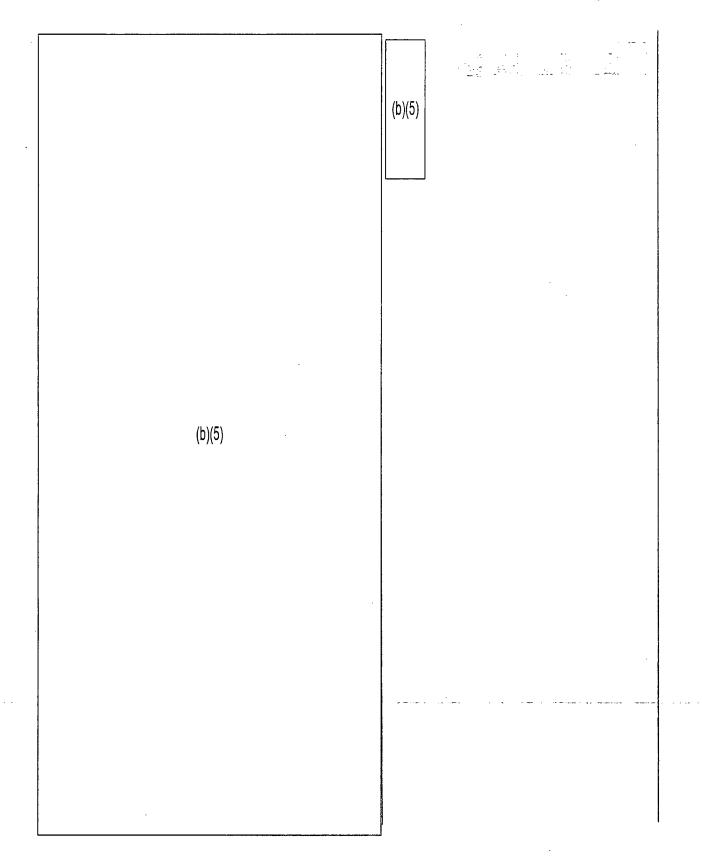
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## Oyama: LAT. 36.2975N, LONG. 139.82199E

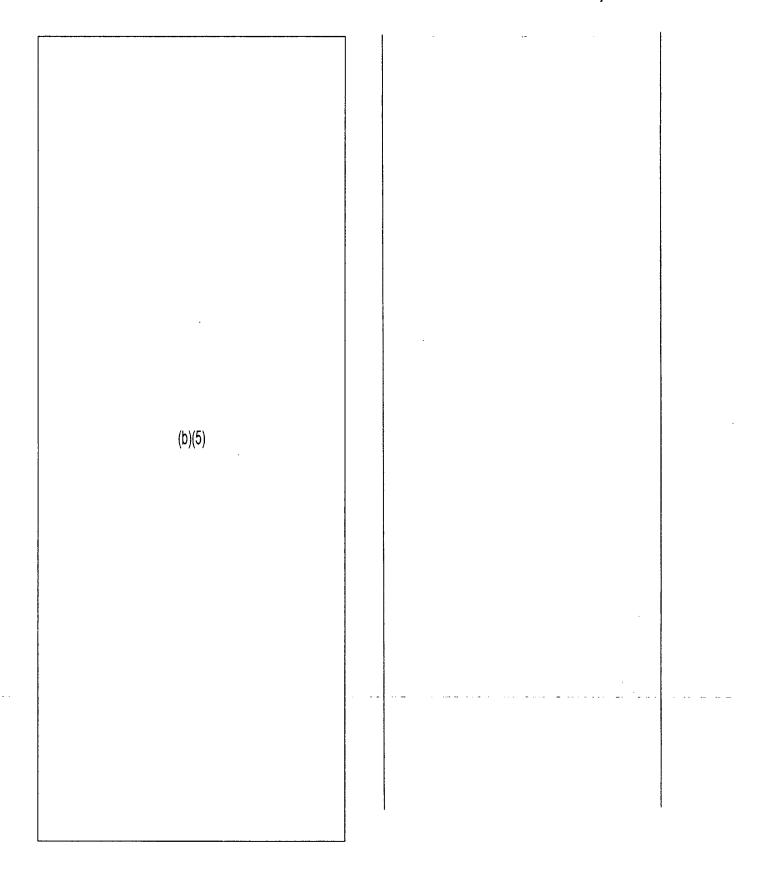
~72 miles north of Yokosuka and 100 miles south of Fukushima



EY 167 of 942



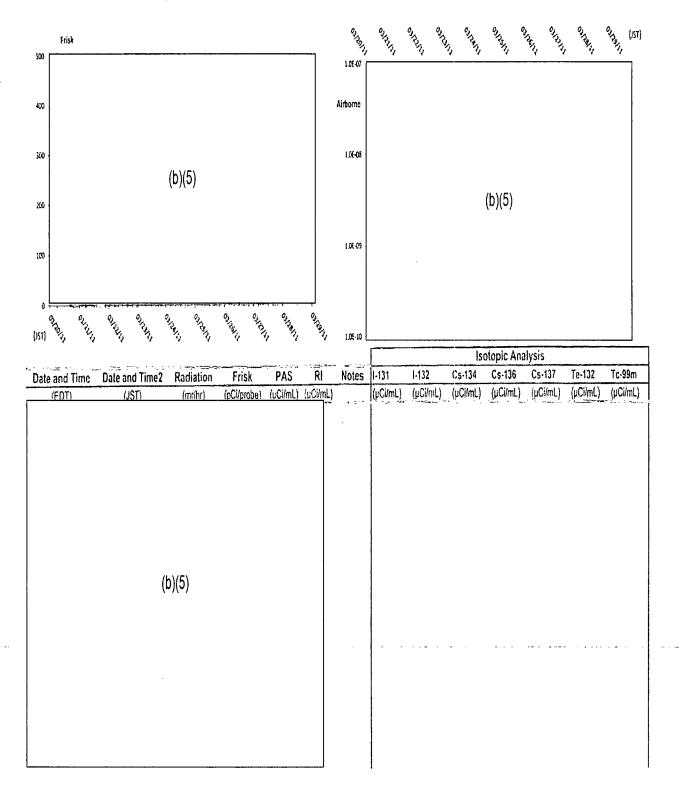
EY 168 of 942



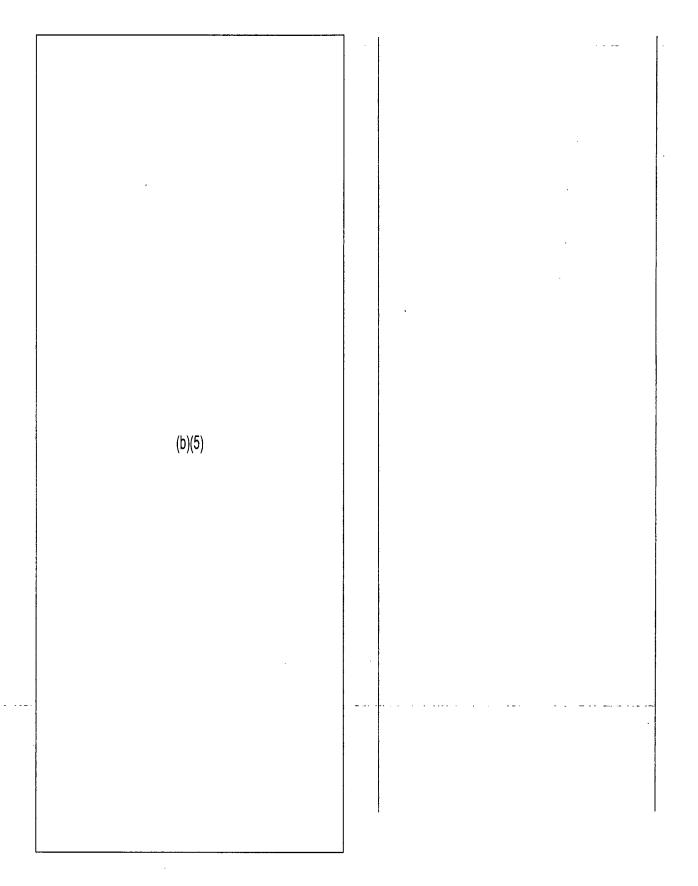
EY 169 of 942

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Notes (b)(5)	

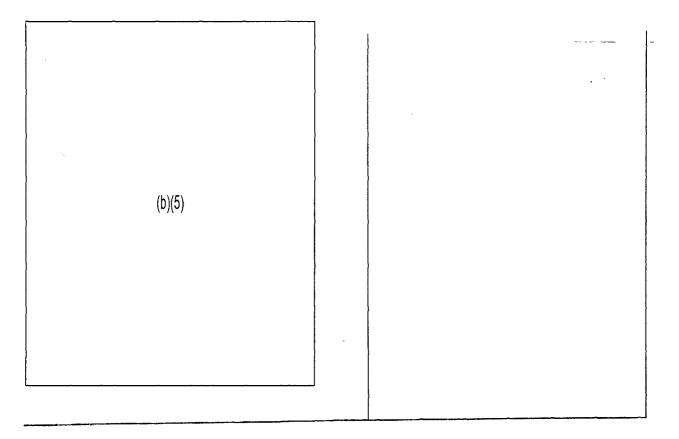
## Misawa NAS: LAT. 40.71N, LONG. 141.37E



EY 171 of 942



EY 172 of 942



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# EY 173 of 942

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From: Sent: To:	RST01 Hoc <u>Thursday, March 31, 2011 11:16 PM</u>		
	(b)(6)		
Cc: Subject: Attachments:	RST07 Hoc; RST01 Hoc FW: Revision to Cover Memo for Rev 1 to the RST Assessment 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,

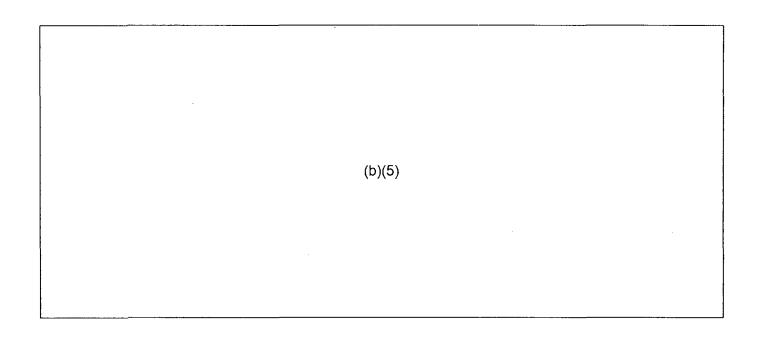
Greg RST Coordinator

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)

EY 175 of 942



#### Bano, Mahmooda

From:Scott, MichaelSent:Thursday, March 31, 2011 7:59 PMTo:'nei-hisanori@meti.go.jp'Cc:RST01 HocSubject:RST Assessment REV 1Attachments: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

EY 176 of 942

From: Sent: To: Cc: Subject: Emche, Danielle Thursday, March 31, 2011 5:55 PM LIA03 Hoc; English, Lance Abrams, Charlotte; LIA02 Hoc 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 – 1 just checked with the PMT. 1 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

<b>F</b>	Minster line
From:	Wiggins, Jim
Sent:	Thursday, March 31, 2011 2:43 PM
То:	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	

**-** .

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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)	
-	(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)

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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.

- 1 Be it enacted by the Senate and House of Representatives of
- 2 the United States of America in Congress assembled,
- 3 SECTION 1. SHORT TITLE.
- 4 This Act may be cited as the "Nuclear Power Plant
- 5 Safety Act of 2011".

1 SEC. 2. NUCLEAR POWER PLANT SAFETY.

2 (a) AMENDMENT.—Chapter 14 of the Atomic Energy

3 Act of 1954 (42 U.S.C. 2201 et seq.) is amended by add-

4 ing at the end the following new section:

5 "SEC. 170J. REVISION OF NUCLEAR POWER PLANT

6 SAFETY REGULATIONS.---

7 "a. Not later than 90 days after the date of enact-

8 ment of the Nuclear Power Plant Safety Act of 2011, the

9 Commission shall initiate a rulemaking proceeding, includ-

10 ing notice and opportunity for public comment, to be com-

11 pleted not later than 18 months after such date of enact-

12 ment, to revise its regulations to ensure that each utiliza-

13 tion facility licensed under this Act can withstand and ade-

14 quately respond to-

15 "(1) an earthquake, tsunami (for a facility lo-

16 cated in a coastal area), strong storm, or other event

17 that threatens a major impact to the facility;

18 "(2) a loss of the primary operating power

19 source for at least 14 days; and

#### -2-

#### EY 182 of 942

"(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

26 facilities, be equipped with resilient containment,

- 3 -

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1	safety, and diagnostic systems sufficient to with
2	stand the circumstances described in subsection a.,
3	including requirements to ensure that the reactor
4	core remains cooled, that the containment remains
5	intact, and that the spent fuel cooling and spent fuel
6	pool integrity are maintained;
7	"(2) a requirement that licensees have at least
8	14 days worth of emergency power system fuel on-
9	site with which to power the licensed facility in the
10	event of a loss of the primary operating power
11	source;
12	"(3) a requirement that licensees have suffi-
13	cient secondary emergency power to power the li-
14	censed facility in the event of a loss of both the pri-
15	mary operating power source and the emergency
16	power system described in paragraph (2) for at least
17	72 hours;
18	"(4) a requirement that licensees develop, and

19 obtain approval from the Commission for, a plan to

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## EY 184 of 942

20 obtain sufficient additional fuel or batteries in the

- 5 -

- 21 event of a long duration loss of operating power or
- 22 total station blackout;

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EY 185 of 942

- 23 "(5) a requirement that licensees amend, and
- 24 obtain approval from the Commission for, any guid-
- 25 ance and strategies developed by the licensees that

1	are intended to maintain or restore core cooling,
2	containment, and spent fuel pool cooling capabilities
3	under the circumstances associated with loss of large
4	areas of the plant due to explosions or fire, in order
5	to incorporate lessons learned from the Fukushima
6	nuclear power plant meltdown into such guidance
7	and strategies;
8	"(6) a requirement that spent nuclear fuel rods
9	be moved from storage pools to certified dry cask
10	storage within one year of the nuclear fuel rods
11	being qualified to be placed in the certified dry
12	casks;
13	"(7) a requirement to configure spent nuclear
14	fuel rods in spent nuclear fuel pools in a manner
15	that would minimize the chance of a fire in the event
16	of the loss of the water in the spent nuclear fuel
17	pool;
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18 "(8) a requirement that emergency response ex-

ercises include scenarios that are based on the nearsimultaneous 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

-7-

- 1 "(9) appropriate requirements for periodic 2 verification of compliance with the regulations issued 3 under this section. 4 "c. The Commission shall not issue an approval for 5 any construction permit, operating license, license exten-6 sion, design certification, combined license, design ap-7 proval, or manufacturing license until the revisions of reg-8 ulations under this section take effect.". 9 (b) CONFORMING AMENDMENT.—The table of con-10 tents of the Atomic Energy Act of 1954 is amended by 11 inserting after the item relating to section 1701 the following new item: 12 "Sec. 170J. Revision of nuclear power plant safety regulations.". 13 SEC. 3. LOAN GUARANTEES. 14 Section 1702(b) of the Energy Policy Act of 2005 15 (42 U.S.C. 16512(b)) is amended by inserting after para-16 graph (2) the following: 17 "In the case of a guarantee for advanced nuclear energy
- 18 facilities, the Secretary shall ensure that the cost of the

- 8 -

- 19 obligation is calculated using a consideration of the
- 20 Tohoku earthquake of 2011 to estimate the risk character-
- 21 istics of the project.".

From:	LIA06 Hoc
Sent:	Thursday, March 31, 2011 7:18 PM
То:	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)

1

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

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If you need any additional information, please advise.

From: Lewis, Robert

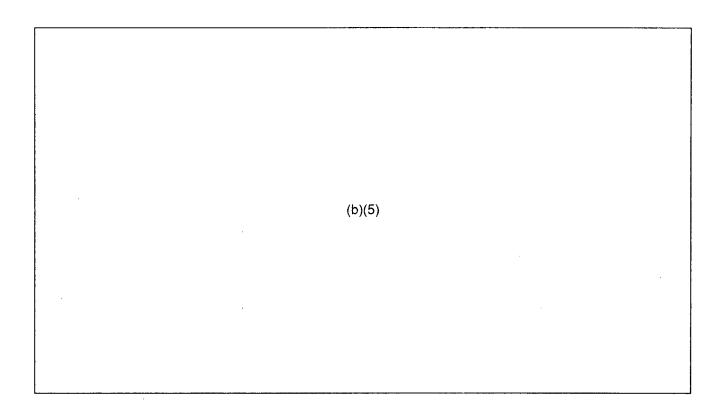
Sent: Thursday, March 31, 2011 3:12 PM

**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)



EY 193 of 942

From:	Bradford, Anna
Sent:	Thursday, March 31, 2011 7:17 PM
То:	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
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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)

(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

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If you need any additional information, please advise.

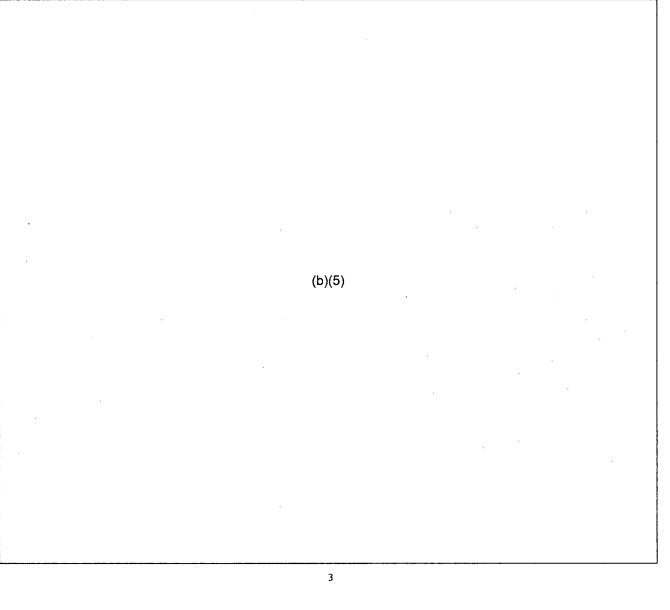
#### From: Lewis, Robert

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

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EY 196 of 942

(b)(5)

4

EY 197 of 942

From:	LIA06 Hoc
Sent:	Thursday, March 31, 2011 6:50 PM
То:	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

Lieison 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

1

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

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If you need any additional information, please advise.

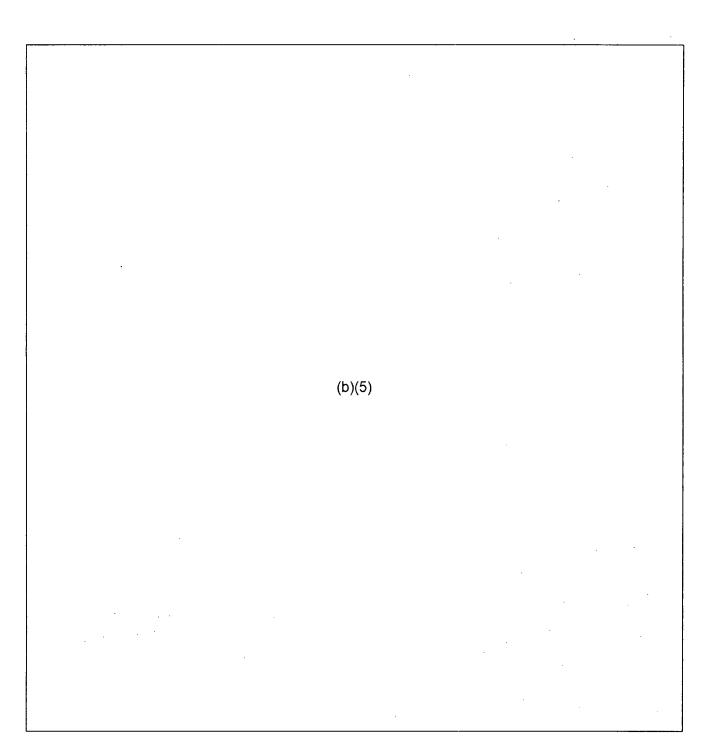
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Sent: Thursday, March 31, 2011 3:12 PM

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EY 200 of 942

LIA06 Hoc
Thursday, March 31, 2011 10:29 PM
Hoc, PMT12
FW: FYI - Background Briefing Material for Principals Committee Meeting
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

EY 201 of 942

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.

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

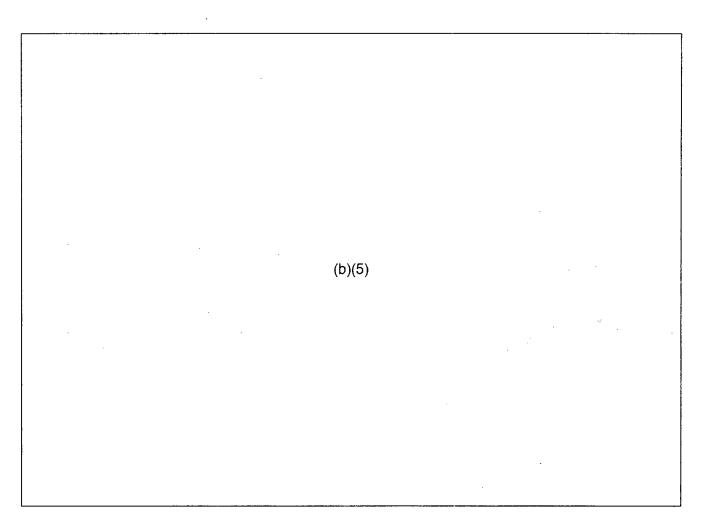
**Subject:** FYI: Summary of IPC meeting, Temporary Radiological Standards for International Cargo Transborder Supply Chain Security IPC

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EY 202 of 942



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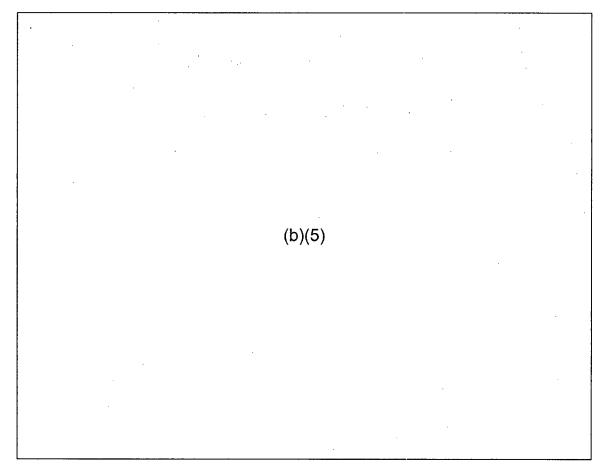
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#### **INFO PAPER**

Purpose

(b)(5)

Background



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<u> </u>	Draft for Discussion Purposes Only - For Official Use Only	السيمينيين .		

EY 204 of 942

#### Draft for Discussion Purposes Only - For Official Use Only

#### Additional Information Necessary:

(b)(5)

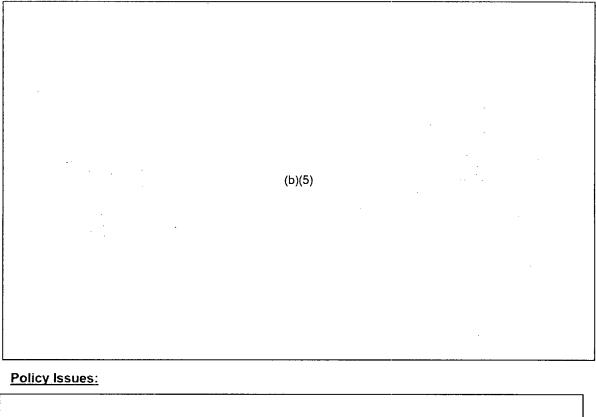
#### **Discussion**

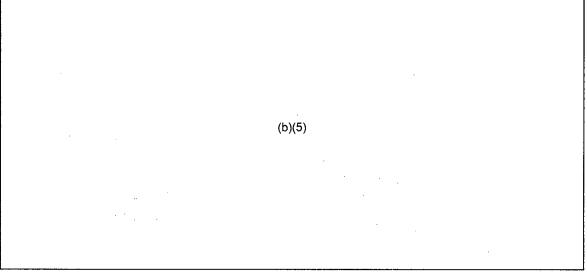
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EY 205 of 942

#### Draft for Discussion Purposes Only ---For-Official-Use Only



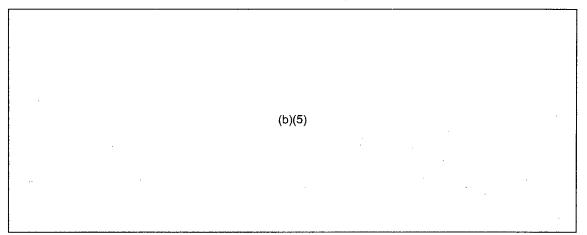


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EY 206 of 942

#### Draft for Discussion Purposes Only - For Official Use Only -



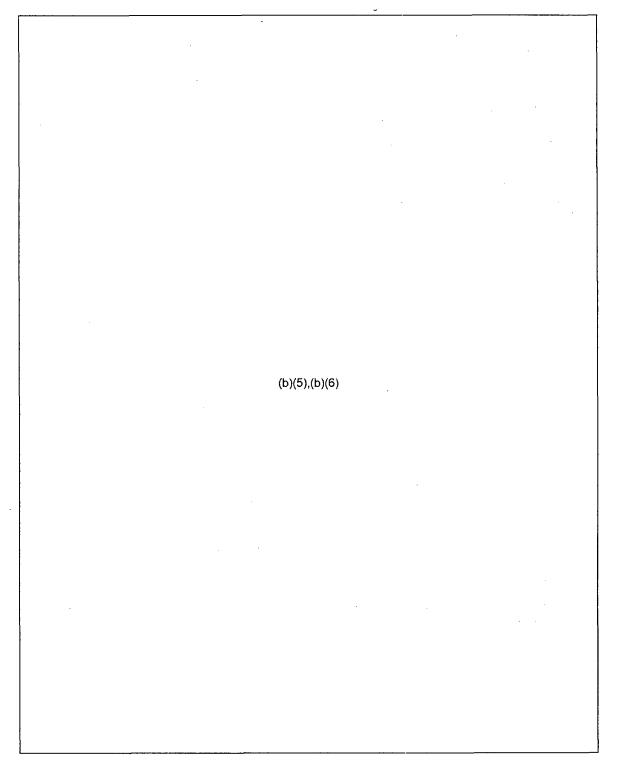
Draft for Discussion Purposes Only \_For Official Use Only

EY 207 of 942

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#### NATIONAL SECURITY STAFF WASHINGTON, D.C. 20504

March 30, 2011



EY 208 of 942

Attachment Tab A Agenda .

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EY 209 of 942

EY 210 of 942

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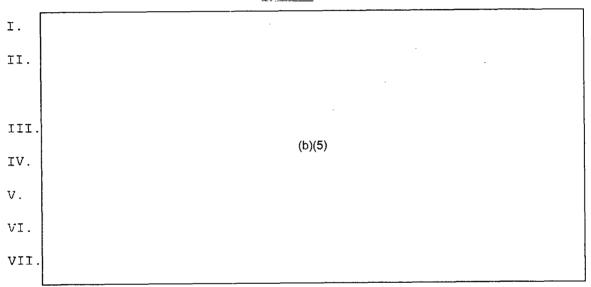
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Tab A

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PRINCIPALS COMMITTEE MEETING ON JAPAN

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



AGENDA

#### 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 Lis (Consortium Call) Rev 1 03 29 (2).xlsx	st
Attachments:	Japanese Government Action Items and Material Request List (Consortium Call) Rev 1 ( (2) xlsx	)3 29

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)

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. . .

**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)

EY 212 of 942

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#### DISCLAIMER:

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Diank You

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EY 213 of 942

## \*\*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

ltem#		Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
1	(b)(5)	INPO INPO	(b)(5)	Open Closed	(b)(5)	
4	,	INPO		Open Closed Open		

Occument is current as of: 1:14 AM 1/20/2011

## \*\*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

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

Document is current as of:

7:14 AM 4/20/2011

EY 215 of 942

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

Document is current as of: ':14 AM I/20/2011

Japanese Government Action Items and Material Request List (to be considered during Consortium Calls) \*\*DRAFT\*\* EY 216 of 942 and 8

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

Page 4 of 8

EY 217 of 942

ltem#		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	7			Open		
18	3			Open		

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

\*\*DRAFT\*\*

EY 219 of 942

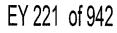
ltem#		Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
23				Open		
24				Open		
25		(b)(5)		Open		
26	(b)(5)			Open		
27 28			(b)(5)	Open Open		_
					(b)(5)	
29				Closed 3/29		

Occument is current as of: ':14 AM -/20/2011

ltem#		Coordinating Agency	Current Status and Expected timing	Open Closed	Comments	Orginal Requesting Agency
			· · ···			-
30				Open		
					(b)(5)	
31	(b)(5)	(b)(5)		Open		
32				Open		
33				Open		
34				Onen		
35				Open		
36	· · · · · · · · · · · · · · · · · · ·					

Japanese Government Action Items and Material Request List (to be considered during Consortium Calls) \*\*DRAFT\*\*

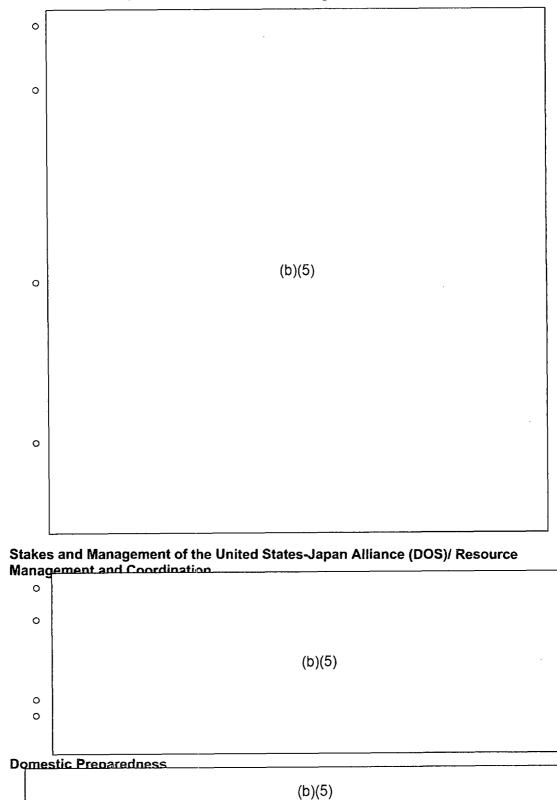
Page 8 of 8



From:Hoc, PMT12Sent:Friday, April 01, 2011 7:57 AMTo:Blount, TomCc:ET07 HocSubject:Commission/ Chairmen UpdateAttachments:Major dose assessment matrix\_03312011.xlsx; 2011 04-01 Re-entry criteria Task 3108<br/>(2) (3).doc

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7**4**-

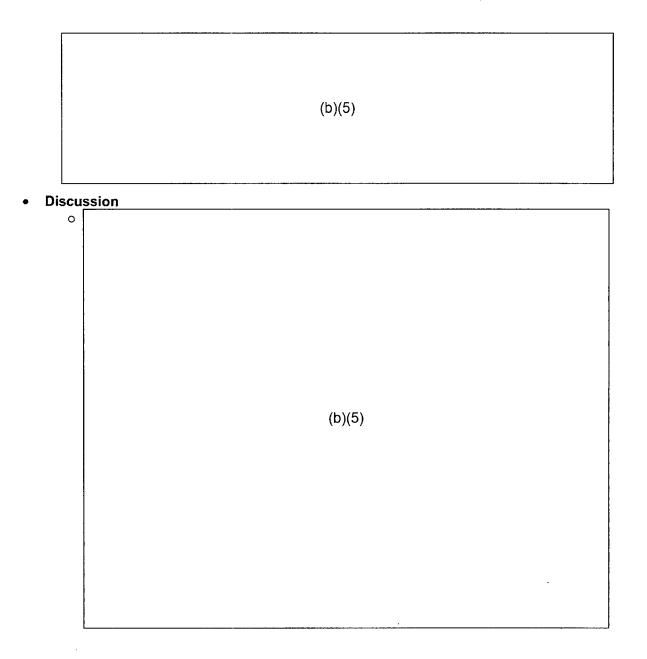


• U.S. Citizens in Japan: Thresholds and Planning

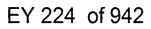
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EY 223 of 942



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From:ET07 HocSent:Friday, April 01, 2011 8:56 AMTo:LIA07 HocSubject:FW: HEADS UP - USNRC REACTOR SAFETY TEAM ASSESSMENT REV 1Attachments:03-31-11 1200 RST Assessment Document REV 1 .docx; RST ASSESSMENT<br/>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)

1

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

# EY 226 of 942

 From:
 佐茲隆

 To:
 Taylor, Robert

 Subject:
 Radiation Dose Map

 Date:
 Friday, April 01, 2011 10:02:56 AM

 Attachments:
 20110401 iFSurveyMap.ppt

Dear Mr. Taylor

Attached contains the revised dose map of Fukushima Daiichi site.

I appreciate your support.

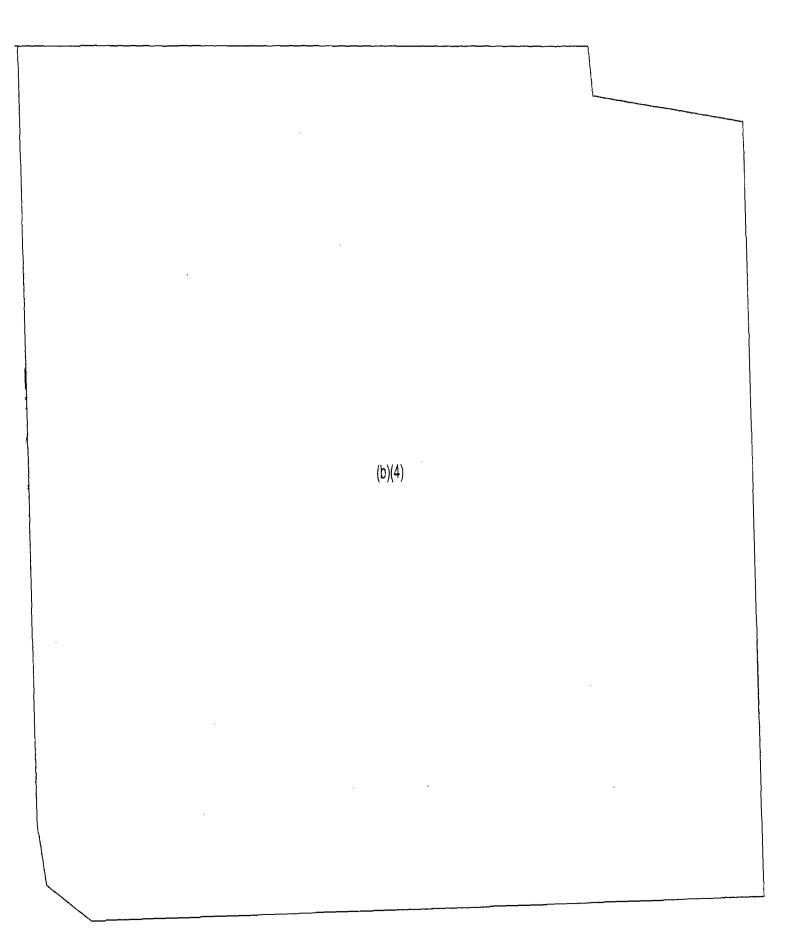
Best regards,

Takashi Sato TEPCO

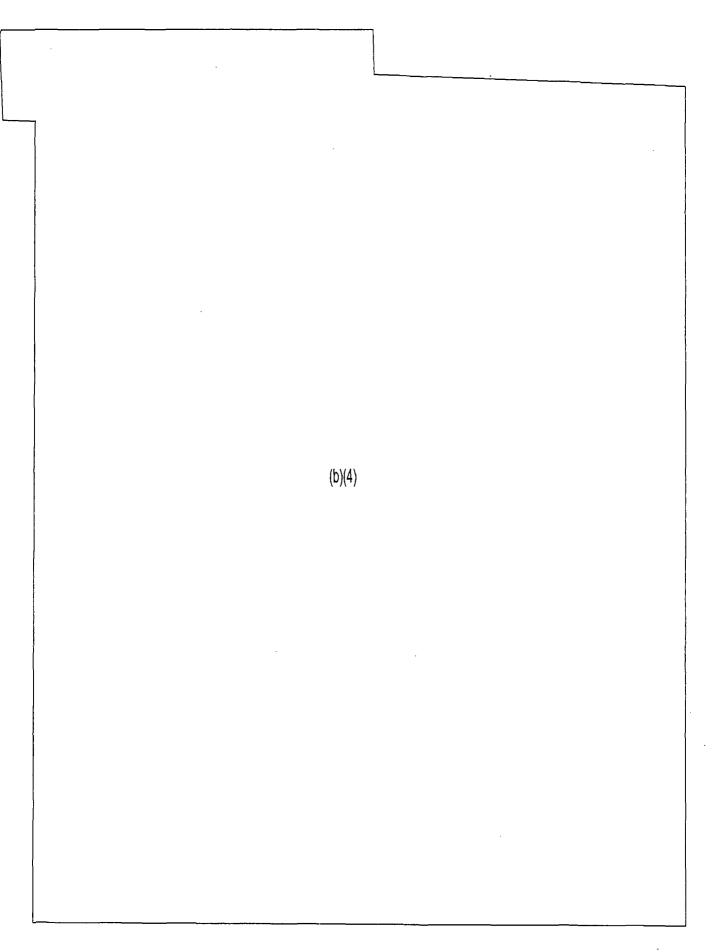
東京電力株式会社 本店 子力・立 業務 子力企画グループマネージャー 佐藤 隆(Takashi Sato) 〒100-8560 東京都千代田区内幸町1-1-3 TEL:03-6373-4721 FAX:03-3596-8538 E-Mail:satoh.takashi@tepco.co.jp

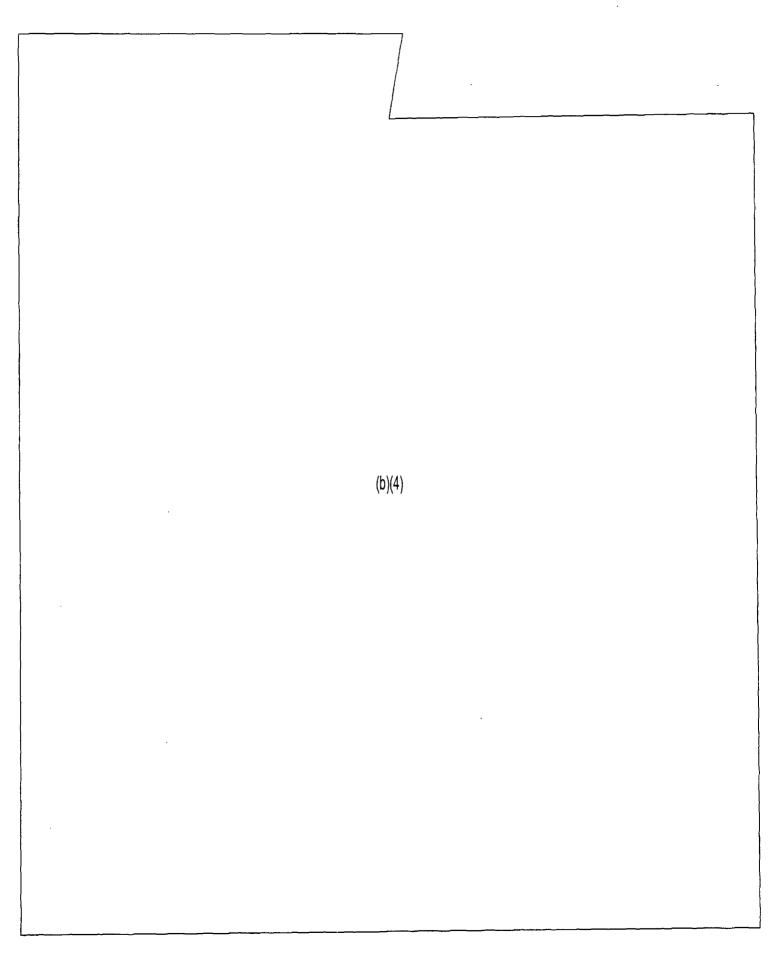
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EY 228 of 942





### Depta, George (GE Power & Water)

From:	GE Hitachi Nuclear Response Team (GE Power & Water)
Sent:	Friday, April 01, 2011 6:43 AM
То:	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

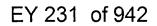
(b)(4)	

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: <u>Stephen.Philpott@nrc.gov</u>



# EY 232 of 942

 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 USFI 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

EY 233 of 942

Subject: BWR Radiation Fields

(b)(4)

Jim Keithley

Sr. Evaluator

**Radiological Protection** 

Institute of Nuclear Power Operations

(b)(6)

(770) 644-8741

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EY 235 of 942

From: Sent: To: Subject: Attachments: RST01 Hoc Friday, April 01, 2011 7:37 AM Blount, Tom; ET07 Hoc FW: RST Assessment of Fukushima Daiichi Units (Rev 1) 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: Tavlor. 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)

1



(b)(5)

Let me know if you have any questions

Mike

Mike Brown Reactor Safety Team

### 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)

EY 238 of 942

#### 1200 hrs 3/31/2011

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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

### 1200 hrs 3/31/2011

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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 unkn	own.			
(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:

### 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.

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.

EY 241 of 942

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.

**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.

۶	Inject into the RPV with all av	ailable resources	(b)(4),(b)(5)
		(b)(4),(b)(5)	
A	Vent containment Considerations A. I. through A a. To maintain containme		(See Additional
		in RPV injection above	
	c. d.	(b)(4),(b)(5	
A			
A		(b)(4),(b)(5)	

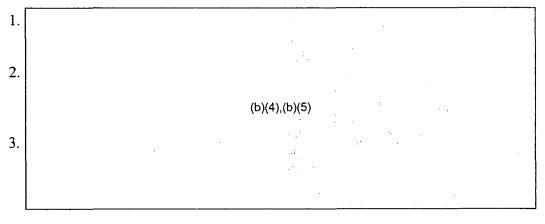
Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

# **Additional Considerations**

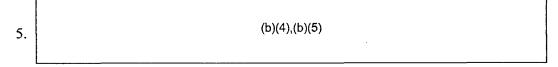
A. The following considerations apply to containment venting:

## 1200 hrs 3/31/2011

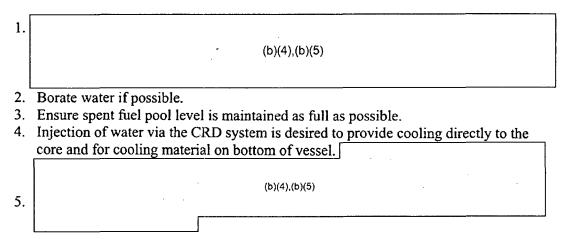
The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject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



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



# B. Additional Miscellaneous considerations



# C. Potential methods for monitoring containment level:

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

# EY 243 of 942

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.

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)
L	

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

1200 hrs 3/31/2011

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degrees centigrade or 115 degrees Fahrenheit. (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

# 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.

۶	Inject into the RPV with all available resources (b)(4),(b)(5)						
	(b)(4),(b)(5)						
	a. <u>core spray</u> (b)(4),(b)(5)						
	(b)(4),(b)(5)						
	b. feedwater system						
	c. other systems as they become available						
	d. (b)(4),(b)(5)						
۶							
>							
-							
	(b)(4),(b)(5)						
$\triangleright$							

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)

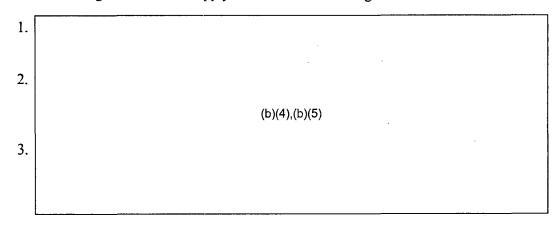
#### 1200 hrs 3/31/2011

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A	(b)(4),(b)(5)
u.	

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:

- 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 mo	nitoring containment level.	(b)(4),(b)(5)
	(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.

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

# **UNIT THREE**

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

Core Status:	Majority of c	ore is probably	contained in reactor vessel;	(b)(4),(b)(5)	
	(b)(4),(b)(5)		TEPCO believes the reactor	water level is 79 in	<u>nch</u> es
	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.

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.

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.

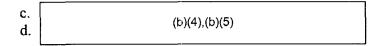
$\triangleright$	Inject	into the RP	'V with all ava	uilable re	sources		(b)(4),(b)(5)	
	(b)(4	4),(b)(5)	:					
	a.	core spray	/		(b)	)(4),(b)(5)		
			(b)(4),(b)(5)					
	b.	feedwater	system		1			
	с.		ems as they be	ecome av	ailable			
	d.		p)(4),(b)(5)					
			<u></u>	ł				
$\triangleright$								
۶								
								Í
				(	o)(4),(b)(5)			
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t								
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<i>¥</i>								

> 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.

### 1200 hrs 3/31/2011

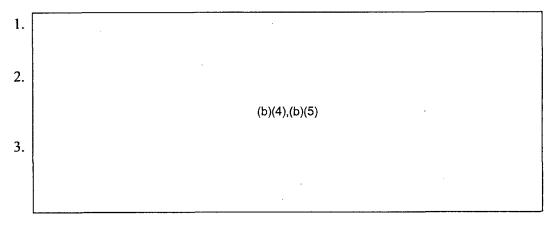
The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject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



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:



- 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.

#### 1200 hrs 3/31/2011

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C.		al methods for monitoring contain (b)(4),(b)(5)	ment level.	(b)(4),(b)(5)	
	a.		PCI (b)(4),(b)	(5) suction pressure and Dry	well
	h	instrument taps Radiation monitoring instruments	<b></b>	(b)(4),(b)(5)	
	υ.				
	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

#### 1200 hrs 3/31/2011

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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.

#### 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.

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		A		
GE Hitachi				
INPO				
DOE/NE		(b)(4),(b)(5),(l	b)(6)	
EPRI				

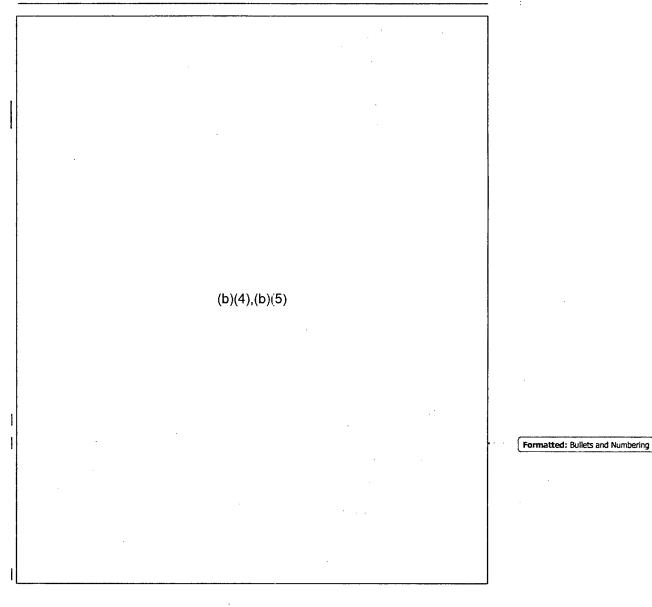
EY 256 of 942

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
Attachments:	Q377 K31 Assessment Spent Pool Pool Document Key o Gen Markup.dock
Erom: CE Hitachi Nuclear Decoor	se Team (GE Power & Water) [mailto] (b)(6)
Sent: Saturday, April 02, 2011 8:	04 AM
To: RST01 Hoc	
Subject: RE: RST Spent Fuel Poo	Assessment
· · · · · · · · · · · · · · · · · · ·	(b)(4)
GEH ICC	
E DOTOL IL . F	
From: RST01 Hoc [mailto:RST01.	
Sent: Friday, April 01, 2011 7:10	
	Team (GE Power & Water); INPO EmergencyResponseCtr (INPO); Modeen, David;
RST03 Hoc; Casto, Chuck; Taylor,	, Robert; Scott, Michael
Subject: FW: RST Spent Fuel Po	
· .	
From: RST07 Hoc	
Sent: Friday, April 01, 2011 6:58	AM
To: RST01 Hoc	
Cc: RST07 Hoc; RST08 Hoc; RST0	06 Hoc
Subject: RST Spent Fuel Pool As	
and the second states	

Attached please see the initial draft of the Spent Fuel Pool Assessment Document. Please provide your comments to the RST team.

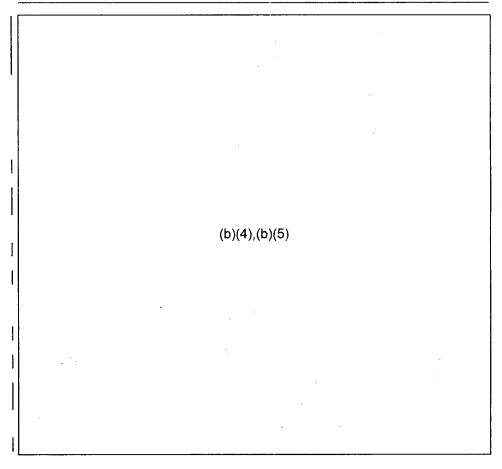
#### 2400 hrs 4/01/2011

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.



#### 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 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 b	pottom drain and 277.8 °C at FW nozzle (TEPCO 0700 JDT 3/30)

Page 2

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	2400 hrs 4/01/ The purpose of the Fukushima	Official Use Only- RST Assessment of Fukushima Daiichi Units (REV 0), ost recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis an KAPL), and DOE/NE 2011 This document is to provide the NRC Reactor Safety Team's assessment and recommendations for Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations as st available technical information. We acknowledge that the information is subject to change and	or ire	
		(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 11:3 JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power h been restored to the Main Control Room Panels (3/29/11 TEPCO).		
ı		Reactor water is in the Turbine Building basement (NISA).	$\backslash$	
		(b)(4),(b)(5)		
	ASSESSME	NT:		
		(b)(4),(b)(5)		
		ENDATIONS: (b)(4),(b)(5)		
	(b)(4),	(b)(5)		
1	> > >	(b)(4),(b)(5)		
	Additional (	Considerations		
	А. <del></del> ]	(b)(4),(b)(5)		Formatted: Bullets and Numbering

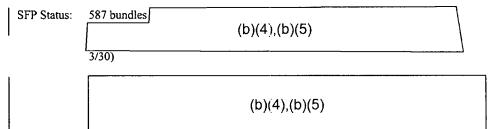
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#### 2400 hrs 4/01/2011

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#### **UNIT TWO**

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

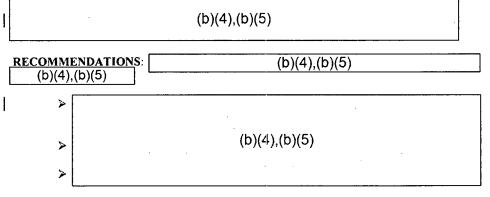


Rad Levels: Drywell 3999 R/hr; Torus 128 R/hr (CAMS);

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:**



**Additional Considerations** 

RST Assessment of Fukushima Daüchi 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

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<u>€.</u> <u>F</u>	(b)(4),(b)(5)	•••	Formatted: Bullets and Numbering

#### **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)	

>	
۶	(b)(4),(b)(5)

- Official Use Only-				
RST Assessment of Fukushima Dalichi 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

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

**Additional Considerations** 

	(b)(4),(b)(5)		matted: Bullets and Numbering matted: Bullets and Numbering
UNIT FOUR		· .	

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

SFP Status:	1331 bundles in SFP	١
	(b)(4),(b)(5)	
	Low water level, spraying with sea water, hydrogen from the fuel pool explode (b)(4),(b)(5) fuel pool is cool heating up very slowly (JAIF, NISA, TEPC Temperature is unknown (NISA).	

#### Rad Levels:

No information.

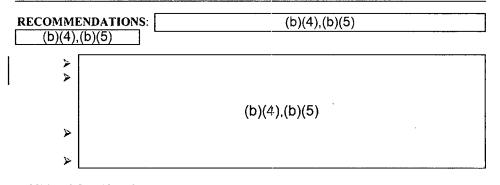
Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. (JAIF, NISA, TEPCO)

#### ASSESSMENT:

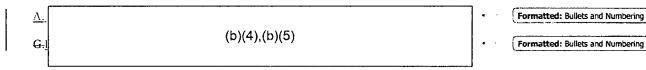
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	(b)(4),(b)(5)	)		
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#### 2400 hrs 4/01/2011

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.



#### **Additional Considerations**



#### **UNIT FIVE**

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

#### Spent Fuel Pool:

```
Fuel pool cooling functioning Temperature 37.9 <u>°C</u>∈ (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

#### 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.

Page 8

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EY 265 of 942

#### 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 SIX

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

Spent Fuel Pool:

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

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

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!

EY 268 of 942

## Rackel

Rachel C. Boyer

Administrative Assistant for Michael Weber

Office of the Executive Director for Operations

U.S. Nuclean Regulatory Commission

🕿 Office: (301) 415-1707

昌 Jax: (301) 415-2162

D Mail Stop: 016-E15

🔅 E-mail: Rachel.Boyer@nrc.gov

From: Sent: To: Subject: Attachments: Powell, Amy Thursday, April 07, 2011 2:58 PM Batkin, Joshua FW: RST Assessemnts 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

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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.

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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.

1

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

EY 271 of 942

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 (MDRIR). Recirculation pump scals 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 scawater injected - (JAIF, NISA, TEPCO). The fuel in this pool is all over 12 years old and very little heat input (<0.1 MW) (DOE)</li>
 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.

## EY 272 of 942

#### 2100 hrs 3/26/2011

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#### **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, Lcg 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.

#### 2100 hrs 3/26/2011

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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.)

## EY 274 of 942

#### 2100 hrs 3/26/2011

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- 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

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#### **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.

2100 hrs 3/26/2011

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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. Restorc 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)

Page 6

## EY 277 of 942

2100 hrs 3/26/2011

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#### **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.

2100 hrs 3/26/2011

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- 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

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#### **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 scals, 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.

#### 2100 hrs 3/26/2011

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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, Lcg 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.

#### 2100 hrs 3/26/2011

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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.)

2100 hrs 3/26/2011

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- 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. HPCl suction pressure
  - 2. Drywell instrument taps
  - 3. Radiation monitoring instruments

2100 hrs 3/26/2011

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#### **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.

#### 2100 hrs 3/26/2011

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#### 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

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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

#### Merzke, Daniel

From:Merzke, DanielSent:Friday, April 08, 2011 2:11 PMTo:Hipschman, Thomas; Castleman, Patrick; Snodderly, Michael; Orders, William; Franovich,<br/>MikeCc:Zorn, JasonSubject:FW: Status of Spent Fuel Pools at FukushimaAttachments: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

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?

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)

[Task Tracker 4131] 1200 Wednesday, April 06, 2011 C:\Documents and Settings\dxm2\Local Settings\Temporary Internet Files\Content.Outlook\RQCDHRBR\04-07-11 2000 RST Assessment Spent Fuel Pool (2).docx

EY 288 of 942

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)

[Task Tracker 4131] 1200 Wednesday, April 06, 2011 C:\Documents and Settings\dxm2\Local Settings\Temporary Internet Files\Content.Outlook\RQCDHRBR\04-07-11 2000 RST Assessment Spent Fuel Pool (2).docx



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# SPENT FUEL POOL STATUS (1400 April 6th)

Fukushima	Daiichi	Unit 1
<u>i unusinina</u>	Duitorit	OTat 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: Criticality status: Fuel Pool Level:	No data No data 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)	

[Task Tracker 4131] C:\Documents and Settings\dxm2\Local Settings\Temporary internet Files\Content.Outlook\RQCDHRBR\04-07-11 2000

1200 Wednesday, April 06, 2011

EY 290 of 942

RST Assessment Spent Fuel Pool (2).docx

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Dailichi 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-

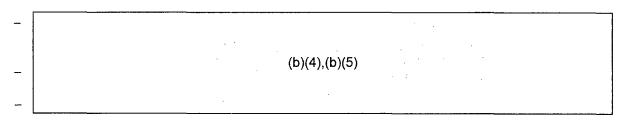
Fukushima	Daiichi	Unit 2

Amount of fuel	:	587 bundles
Last transfer fr	om Reactor:	116 bundles (September 20-25, 2010)
Decay Heat [m	negawatt thermal (MWth)]:	0.47 MWth; evaporation ration rate 5240 gallons per day
Fuel Pool Stru	ctural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Criticality statu Fuel Pool Leve	IS	No data No data Full ((b)(6) 4/3)
Water Injection	n Method and Source:	Fresh water injected to the spent fuel pool
Fuel Pool Wat	er Temperature:	71°C (TEPCO 4/5)
Other:	External AC power has reach energizing.	ed the unit, checking the integrity of equipment before (b)(4),(b)(5)

# Unit 2 Assessment:

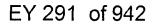
(b)(4),	(b)(5)

# Unit 2 Recommendations:



# Unit 2 Additional Considerations:

- (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. -OFFICIAL USE ONLY-

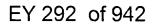
Fukushima Daiichi Unit 3	
Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data 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:

	, <u>, , , , , , , , , , , , , , , </u>		 		
-		(b)(4),(b)(5)			
_	· ·				

Unit 3 Additional Considerations:

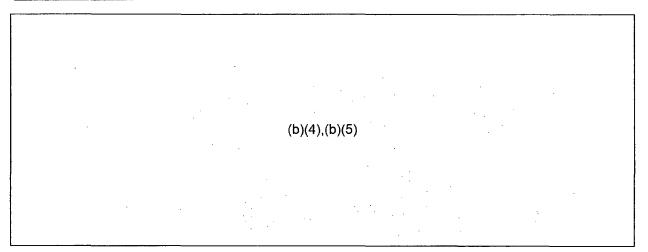
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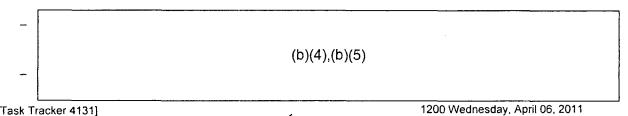
The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information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

<u>Fukushima Da</u>	aiichi Unit 4	
Amount of fue	l:	1331 bundles
Last transfer f	rom Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (N	/Wth):	1.86 MWth
Fuel Pool Stru	ctural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5)
Fuel Pool Lea Criticality statı Fuel Pool Lev	us:	No data Low water level (b)(6) 4/1)
Water Injectio	n Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm
Fuel Pool Wat	ter Temperature:	30°C (JAIF 4/4)
Other:	External AC power has react before energizing.	hed the unit, checking electrical integrity of equipment

Unit 4 Assessment:



Unit 4 Recommendations:



[Task Tracker 4131] 1200 Wednesday, April 06, 2011 C:\Documents and Settings\dxm2\Local Settings\Temporary Internet Files\Content.Outlook\RQCDHRBR\04-07-11 2000 RST Assessment Spent Fuel Pool (2).docx 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-

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

Unit 4 Additional Considerations:

-		
	(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: Criticality status: Fuel Pool Level:	No data No data 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)

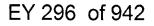


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## Fukushima Daiichi Unit 6

Amount of fuel: 8		876 bundles
Last transfer from Reactor:		184 bundles (August 10-25 2010)
Decay Heat (MW):		0.7 (MW) (b)(6)
Fuel Pool Stru	ctural Support Integrity:	Not damaged (JAIF 4/4)
Criticality status:		No data No data 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 Cooling lost when pump failed pump used for fuel pool cooling		the unit, Unit 6 diesel generators available. Fuel Pool d (JAIF, NISA, TEPCO)/ Repairs complete on RHR ing.
<u>Unit 6 Assess</u>	ment:	
Stable.		
Unit 6 Recommendations:		
		(b)(4),(b)(5)
Unit 6 Additional Considerations:		

-	(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.

Fukushima Daiichi Common SFI	chi Common SFF	hi	Daii	shima	ukus	F
------------------------------	----------------	----	------	-------	------	---

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: Criticality status: Fuel Pool Level:	No data No data 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

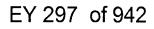
INPO – Institute of Nuclear Power Operations

JAIF – Japan Atomic Industrial Forum

NISA - Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company

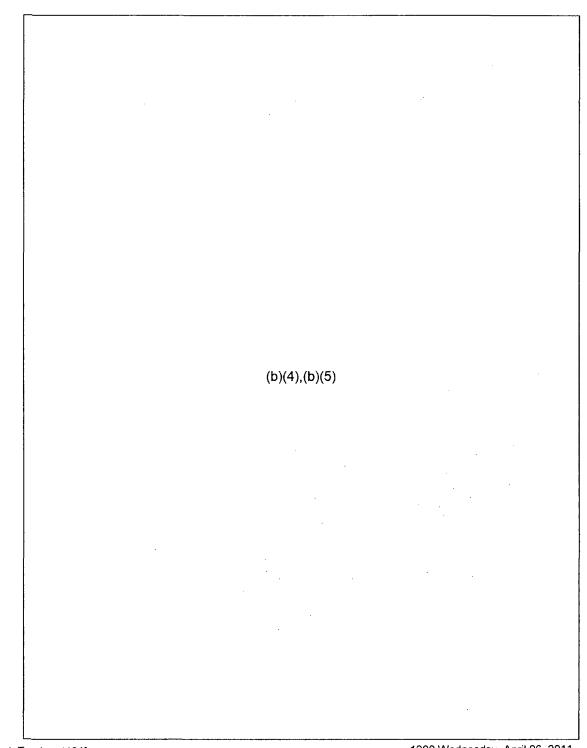
[Task Tracker 4131] 1200 Wednesday, April 06, 2011 C:\Documents and Settings\dxm2\Local Settings\Temporary Internet Files\Content.Outlook\RQCDHRBR\04-07-11 2000 RST Assessment Spent Fuel Pool (2).docx



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-

[Task Tracker 4131] 1200 Wednesday, April 06, 2011 C:\Documents and Settings\dxm2\Local Settings\Temporary Internet Files\Content.Outlook\RQCDHRBR\04-07-11 2000 RST Assessment Spent Fuel Pool (2).docx 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.

# **ENCLOSURE 1**



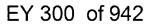
# 1. EPRI recommendations March 18, 2011

[Task Tracker 4131] 1200 Wednesday, April 06, 2011 C:\Documents and Settings\dxm2\Local Settings\Temporary Internet Files\Content.Outlook\RQCDHRBR\04-07-11 2000 RST Assessment Spent Fuel Pool (2).clocx



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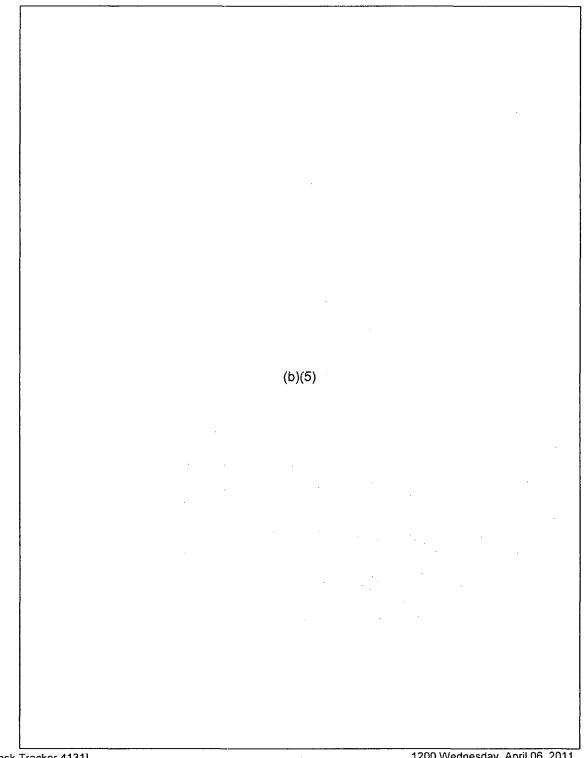
(b)(4),(b)(5)



The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Dailchi 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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#### **ENCLSOURE 2**

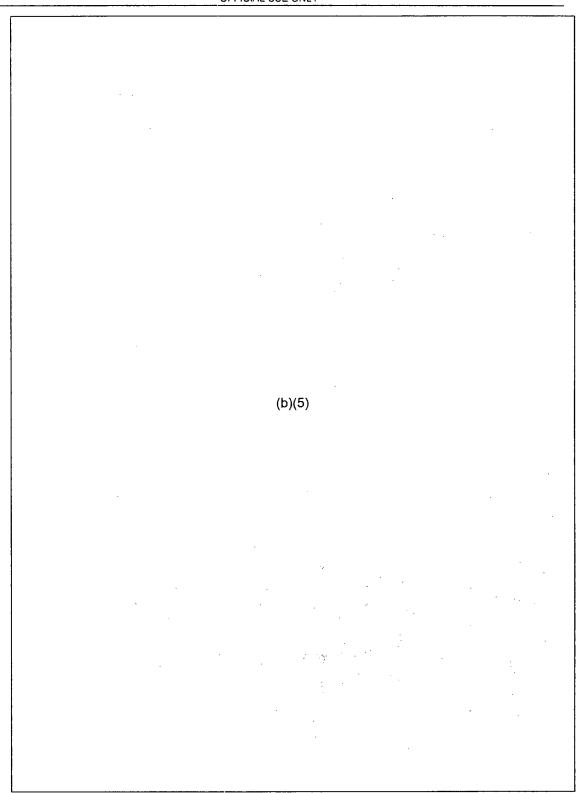


#### SFP Criticality Potential, Kent Wood, March 4, 2011

1200 Wednesday, April 06, 2011 [Task Tracker 4131] C:\Documents and Settings\dxm2\Local Settings\Temporary Internet Files\Content.Outlook\RQCDHRBR\04-07-11 2000 RST Assessment Spent Fuel Pool (2).docx



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-



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EY 302 of 942

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—

# ENCLOSURE 3

	Reactor	Spent fuel pool
Unit 1		292
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

Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

#### 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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Quayle, Lisa -	
From: Sent:	RST01 Hoc Saturday, April 09, 2011 11:11 AM
То:	
Cc:	
	(b)(6)
Subject: Attachments:	FW: FINAL - 04-09-11 1200 RST Assessment Spent Fuel Pool Document 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,

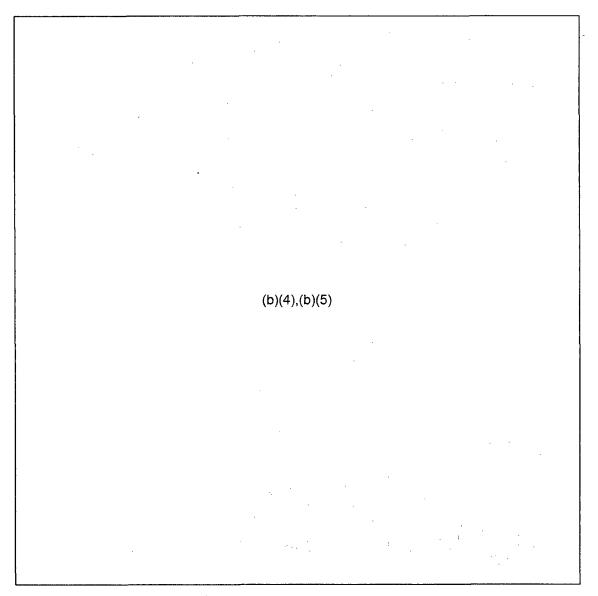
Mike

Mike Brown Reactor Safety Team

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## 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

[Task Tracker 4131] Page 1 FINAL - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\Spent Fuel- 4041\FINAL - 04-09-11 1200 RST Assessment Spent Fuel Pool.docx

EY 305 of 942

SPENT FUEL POOL STATUS (1400 Apri	FICIAL USE ONLY
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: Criticality status: Fuel Pool Level:	No data No data 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	<u>6 JT, a hydrogen explosion occurred during venting</u> (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)

 [Task Tracker 4131]
 Page 2
 FINAL - 1200 April 09, 2011

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 1200 RST Assessment

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 Spent Fuel- 4041\FINAL - 04-09-11
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EY 306 of 942

Fukushima Da	Fukushima Daiichi Unit 2			
Amount of fuel:		587 bundles		
Last transfer from Reactor:		116 bundles (September 20-25, 2010)		
Decay Heat [megawatt thermal (MWth)]: per day		0.47 MWth; evaporation ration rate 5240 gallons		
Fuel Pool Structural Support Integrity:		(b)(4),(b)(5)		
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:		No data No data 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 react before energizing.	ned the unit, checking the integrity of equipment (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)

	OFFICIAL USE ONLY		
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: Criticality status: Fuel Pool Level:	No data No data 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)		
-	(b)(4),(b)(5)		

# Unit 3 Additional Considerations:

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

EY 308 of 942

		IGIAL USE-ONLY		
<u>Fukushima Da</u>	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 Lea		No data		
Criticality status: Fuel Pool Level:		Low water level (b)(6) 4/1)		
Water Injection Method and Source: concrete		Periodic fresh water injected via a hose off of a pumper truck arm		
Fuel Pool Water Temperature:		30°C (JAIF 4/4)		
Other: External AC power has reach equipment before energizing		hed the unit, checking electrical integrity of		

Unit 4 Assessment:

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

Unit 4 Recommendations:

(b)(4),(b)(5)
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 [Task Tracker 4131]
 Page 5
 FINAL - 1200 April 09, 2011

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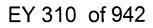
EY 309 of 942

-OFFICIAL USE ONLY

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

Unit 4 Additional Considerations:

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



	OFI	FICIAL USE ONLY			
<u>Fukushima D</u>	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: Criticality status: Fuel Pool Level:		No data No data 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. For Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.		p failed (JAIF, NISA, and TEPCO). Repairs			

Unit 5 Assessment:

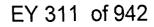
Stable.

Unit 5 Recommendations:

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

Unit 5 Additional Considerations:

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



OFFICIAL USE ONLY-				
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: Criticality status: Fuel Pool Level:		No data No data 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 Pool Cooling lost when pump complete on RHR pump used	the unit, Unit 6 diesel generators available. Fuel failed (JAIF, NISA, and TEPCO). Repairs d for fuel pool cooling.		

## Unit 6 Assessment:

Stable.

Unit 6 Recommendations:

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

Unit 6 Additional Considerations:

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

	DEFICIAL USE ONLY
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: Criticality status: Fuel Pool Level:	No data No data 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

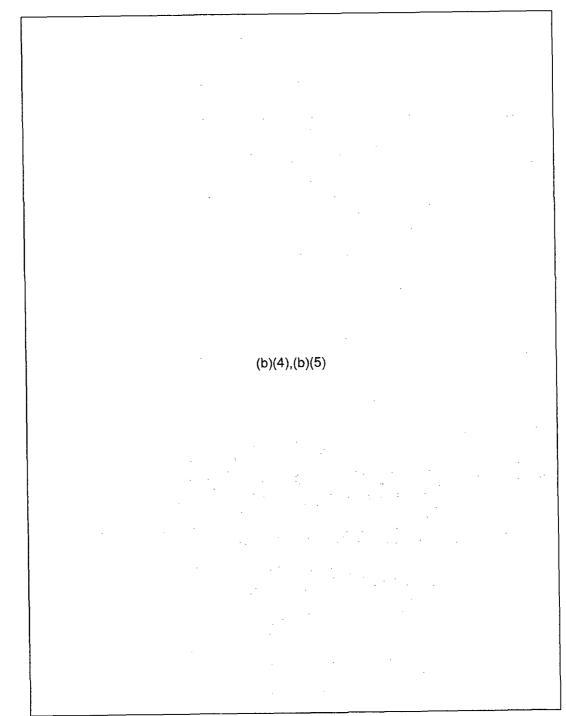
 Page 9
 FINAL - 1200 April 09, 2011

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**ENCLOSURE 1** 



## 1. EPRI recommendations March 18, 2011

[Task Tracker 4131] Page 10 FINAL - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\Spent Fuel- 4041\FINAL - 04-09-11 1200 RST Assessment Spent Fuel Pool.docx

EY 314 of 942

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

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 [Task Tracker 4131]
 Page 11
 FINAL - 1200 April 09, 2011

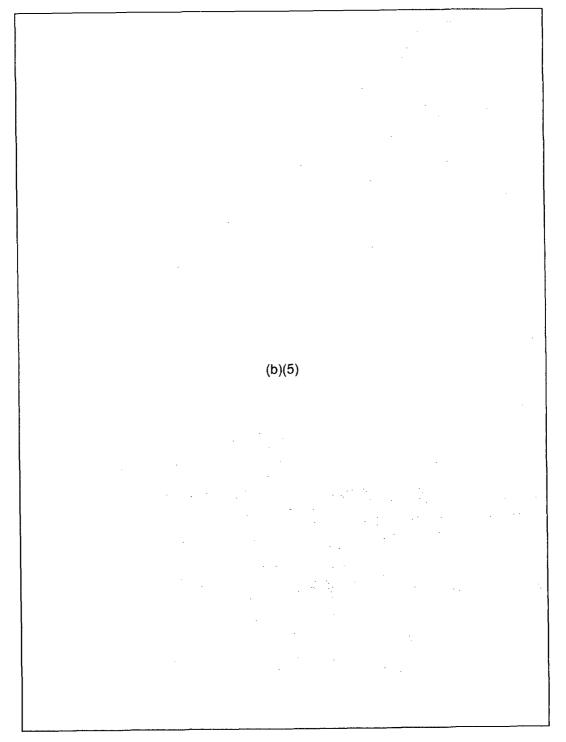
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EY 315 of 942

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#### **ENCLSOURE 2**





[Task Tracker 4131] Page 12 FINAL - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\Spent Fuel- 4041\FINAL - 04-09-11 1200 RST Assessment Spent Fuel Pool.docx

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[Task Tracker 4131] Page 13 FINAL - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\Spent Fuel- 4041\FINAL - 04-09-11 1200 RST Assessment Spent Fuel Pool.docx

EY 317 of 942

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## 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		1. 331
Unit 5	(b)(4)	946
Unit 6		876
Shared pool		6, 375
total		10, 921

#### Fuel assembly type and burn-up

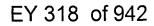
See attachment 1.

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
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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### 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

Eolks (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

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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.

1

Let me know if you have any problems with this process

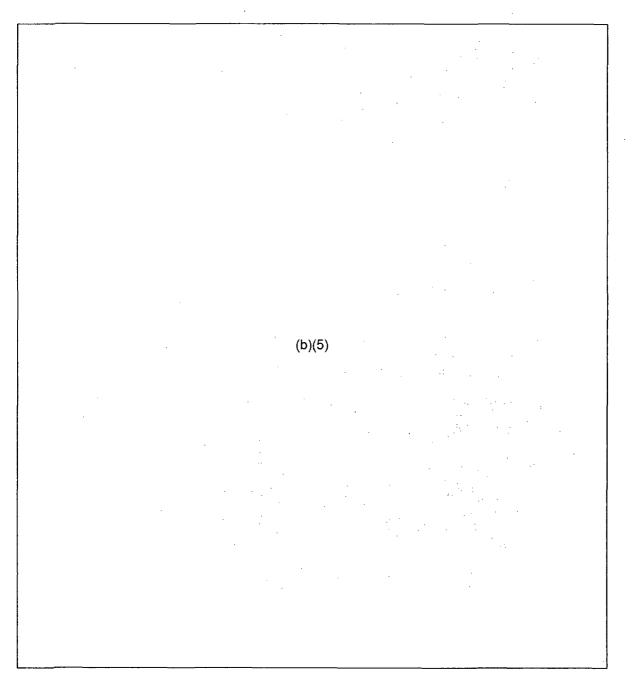
Bill Status Officer \_\_\_\_\_

### UNITED STATES NUCLEAR REGULATORY COMMISSION OFFICE OF NEW REACTORS OFFICE OF NUCLEAR REACTOR REGULATION WASHINGTON, DC 20555-0001

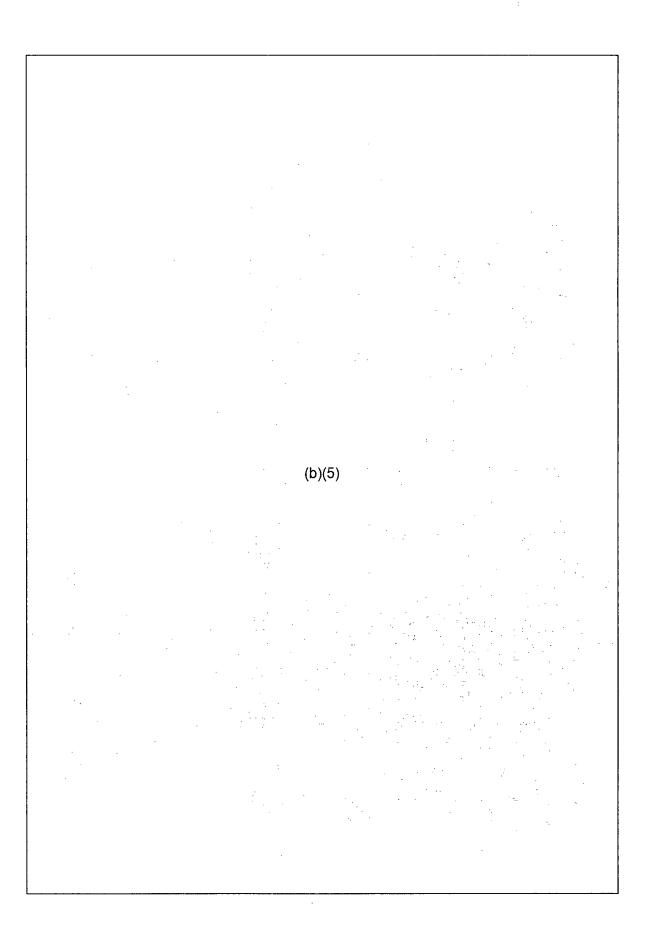
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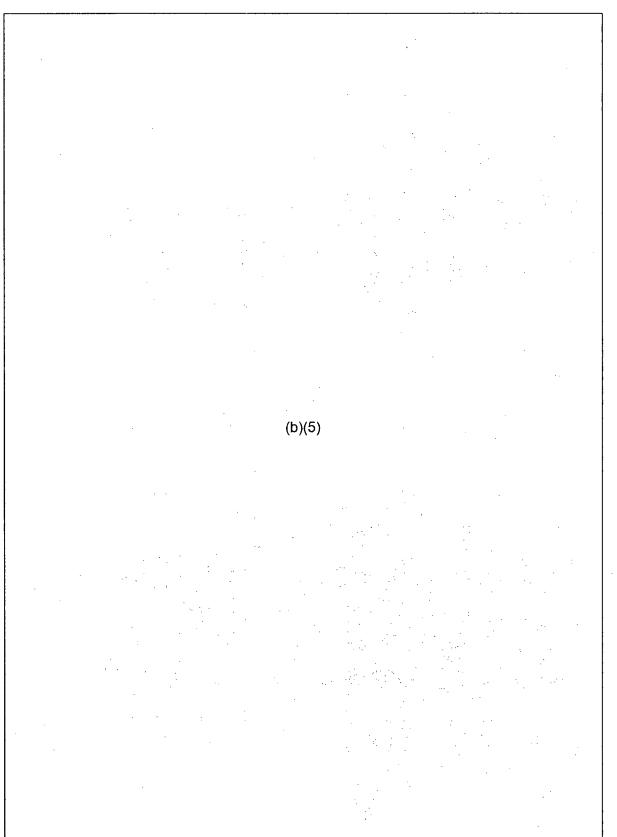
NRC RESPONSE TO FUKUSHIMA EVENT



EY 320 of 942



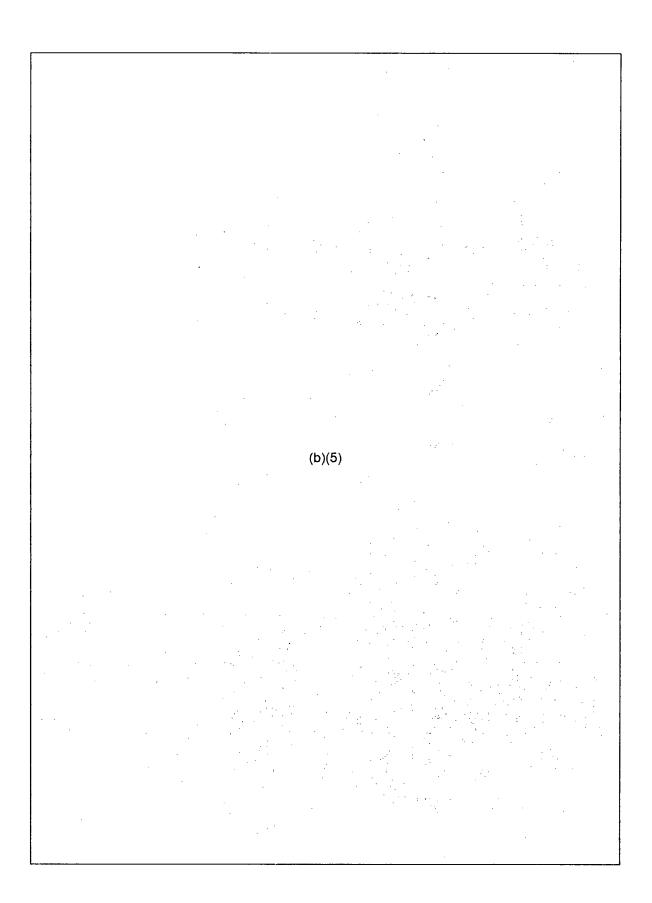
EY 321 of 942



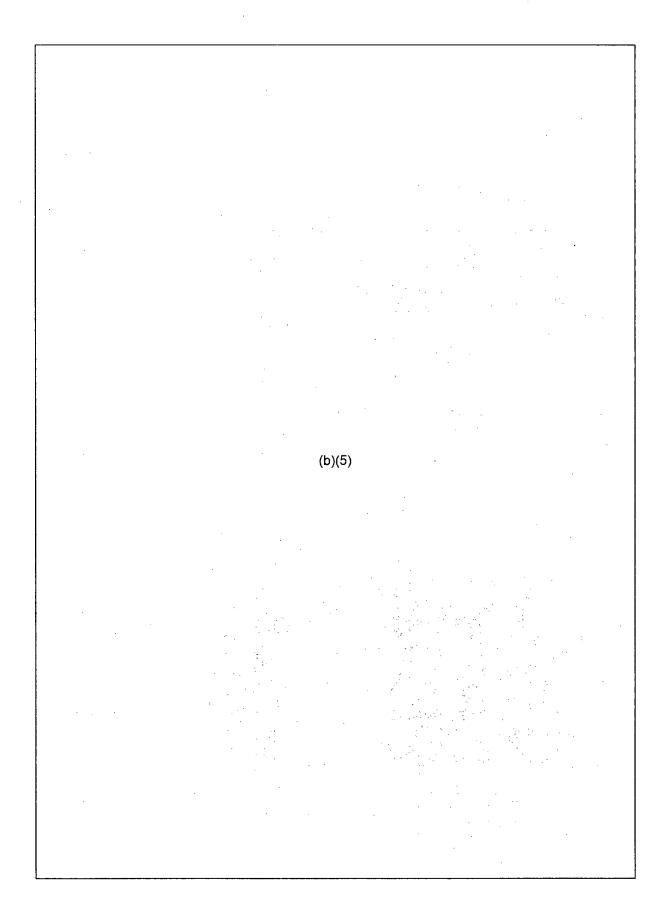
EY 322 of 942

EY 323 of 942

(b)(5)



EY 324 of 942



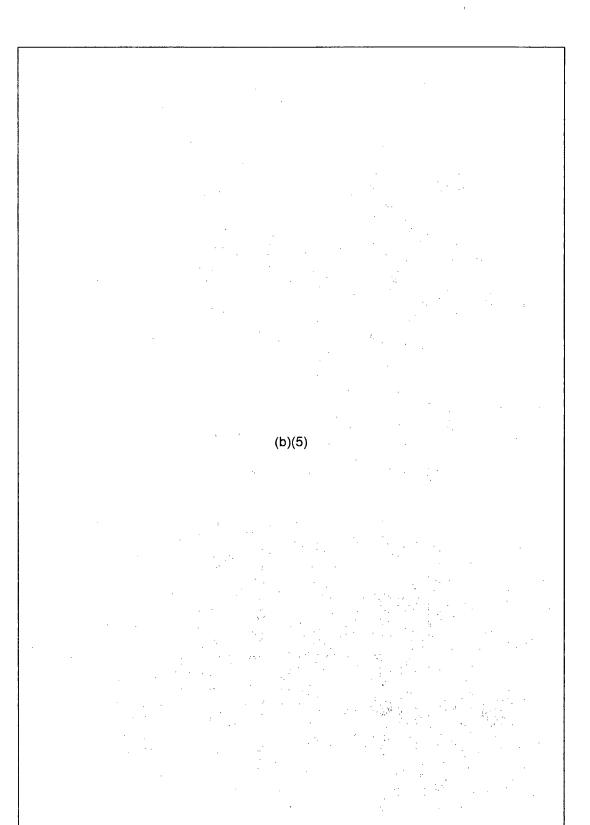
EY 325 of 942

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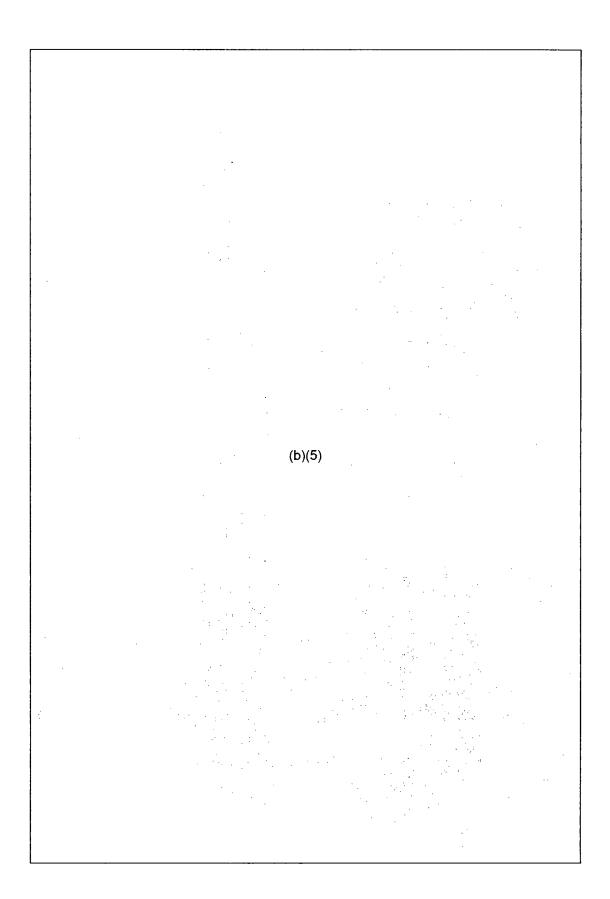
# EY 326 of 942

(b)(5)

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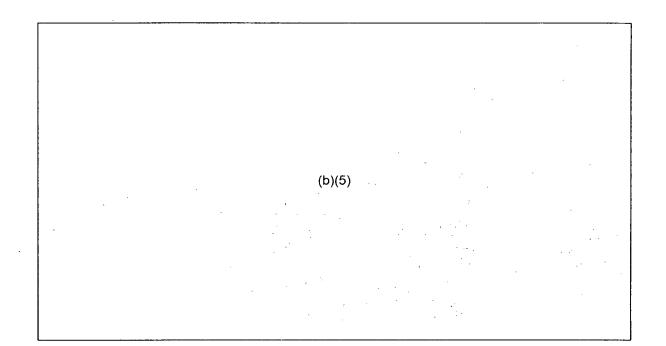


EY 327 of 942



EY 328 of 942

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EY 329 of 942

 From:
 RST01 Hoc

 Sent:
 Saturday, April 09, 2011 2:17 PM

 To:
 (b)(5)

Subject: Attachments: Global Assessment Document (aka - RST Assessment) 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 predecisional document for your review and comments.

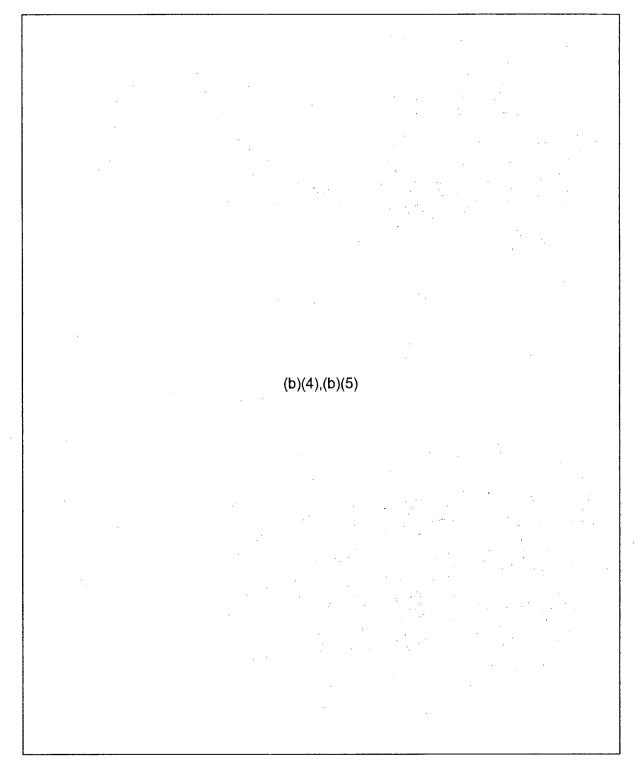
1

**RST** Coordinator

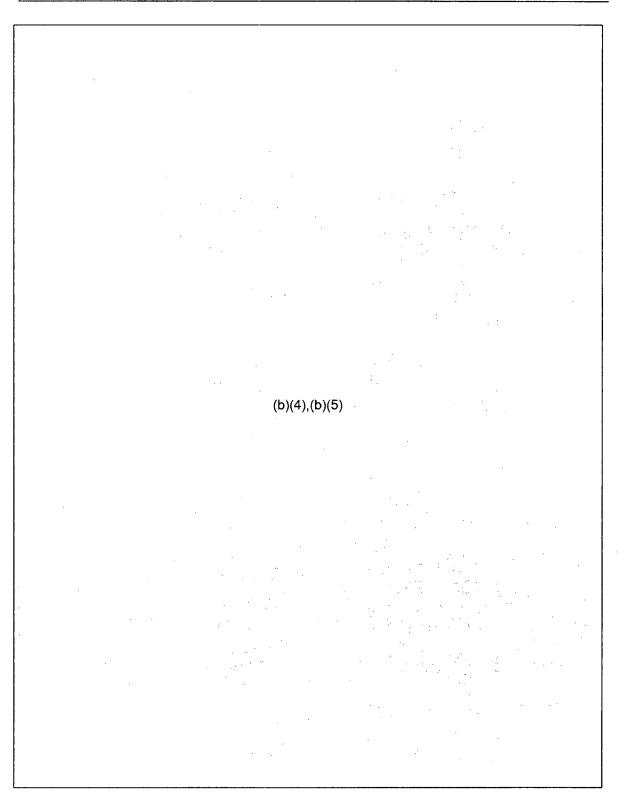
EY 330 of 942

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#### 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

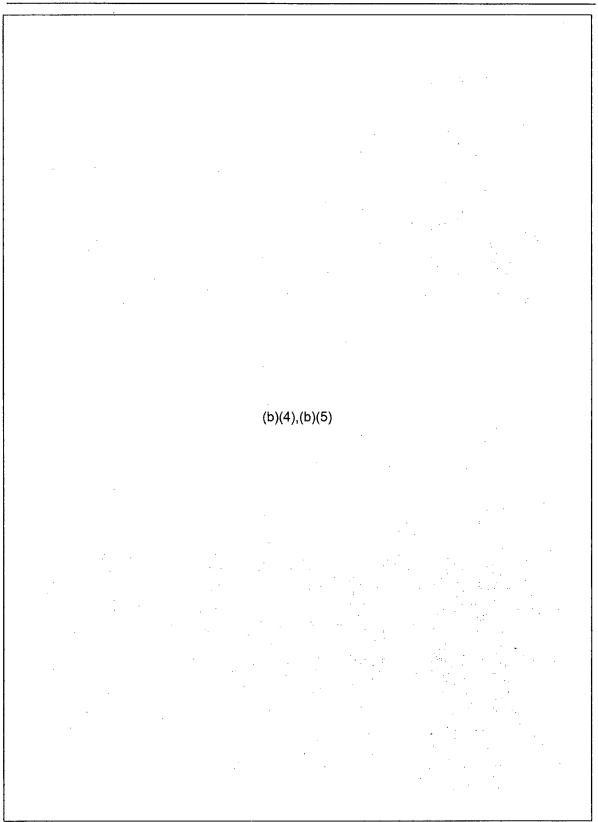


[Task Tracker 4254] Page 1 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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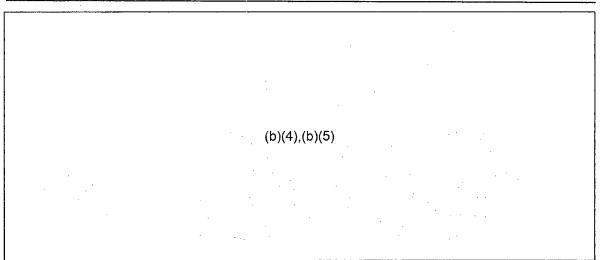




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#### Definitions

<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.

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# 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).

sleauy	(IEI	ruu	4//)	•
	(b)(4	1),(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)

[Task Tracker 4254] Page 5 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi ---OFFICIAL-USE-ONLY

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)

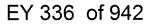
The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

▶ Inject into the RPV with all available resources

	(b)(4),(b)(5)	
L		
Vent containment	(b)(4),(b)(5)	

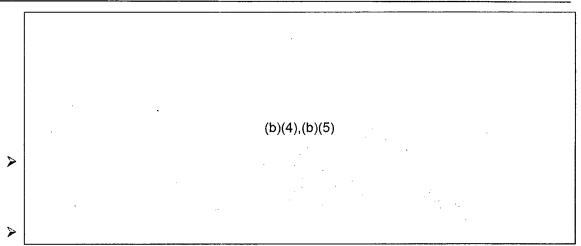
Considerations A.1. through A.5 below)

- 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)



(See Additional

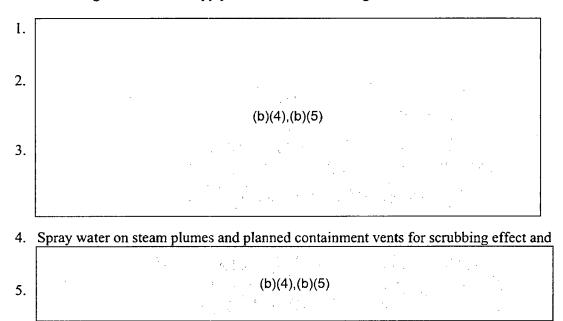
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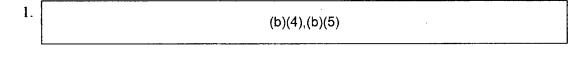
Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

# **Additional Considerations**

A. The following considerations apply to containment venting:



#### B. Additional Miscellaneous considerations



EY 337 of 942

[Task Tracker 4254] Page 7 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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

- 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)	PCI (b)(4).(b)(5) suction pressure and Drywell
2.	instrument taps Radiation monitoring instruments	(b)(4),(b)(5)
3. 4.		(b)(4),(b)(5)
5.		
	······	······································
	(b)(4	4),(b)(5)
	· · · · ·	

[Task Tracker 4254] Page 8 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 338 of 942

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# UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

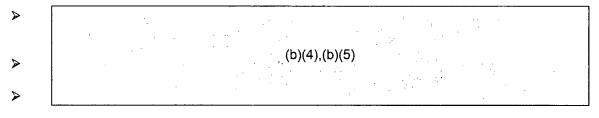
Amount of fuel:	292 bundles	
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)	
Decay Heat [megawatt thermal (MWth)]:	0.07 MWth, evaporation rate 780 gallons per day	
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)	
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data 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)		
(0)(4);(0)(3)		

#### Unit 1 Recommendations:

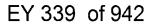


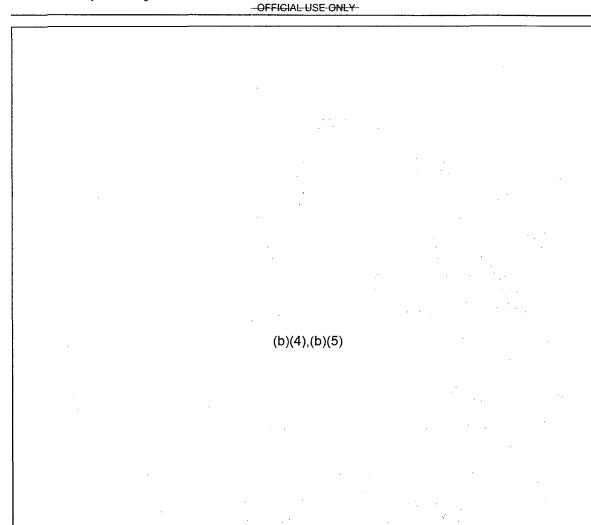
# Unit 1 Additional Considerations:

-

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

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[Task Tracker 4254] Page 10 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

# EY 340 of 942

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# 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 $\downarrow$  (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

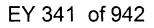
Primary Containment:

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

Drywell pressure reading -0.2  $psig \leftrightarrow (NISA 4/8)$ 

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)



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#### **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 i	s 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.

>		nto the RPV with all availab	le resources (b)(4),(b)(5)
	a.	core spray	(b)(4).(b)(5)
	b. c. d.	(b)(4),(b)(5) feedwater system other systems as they becom (b)(4),(b)(5)	ne available
٨			
۶			(b)(4),(b)(5)

EY 342 of 942

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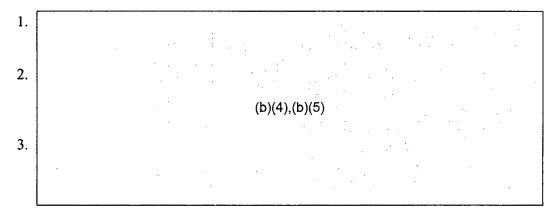
- > Vent containment: (see Additional Considerations A.1. through A.5. below)
  - a. To maintain containment pressure below the primary containment pressure limit.
  - b. As necessary to maintain RPV injection above MDRIR.

c.	(b)(4),(b)(5)
d.	(b)(4),(b)(3)

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:



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

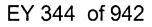


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5.	(b)(4),(b)(5)

- 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.		ial methods for monitoring containment (b)(4),(b)(5)	level. (b)(4),(b)(5)
	a.	(b)(4),(b)(5) HPCI (1)	b)(4);(b)(5)suction pressure and Drywell
	b.	Radiation monitoring instruments	(b)(4),(b)(5)
	c. d.	(b)(4),(	(b)(5)
	e.		



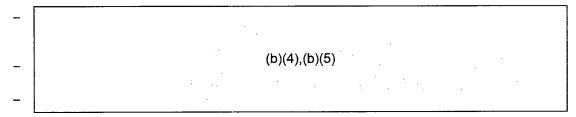
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#### **UNIT 2 - SPENT FUEL POOL STATUS**

Amount of fuel:		587 bundles
Last transfer from Reactor:		116 bundles (September 20-25, 2010)
Decay Heat [megawatt thermal (MWth)]: per day		0.47 MWth; evaporation ration rate 5240 gallons
Fuel Pool Structural Support Integrity:		(b)(4),(b)(5)
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:		No data No data 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 react before energizing.	ned the unit, checking the integrity of equipment (b)(4),(b)(5)
Unit 2 Assess	ment:	

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

Unit 2 Recommendations:

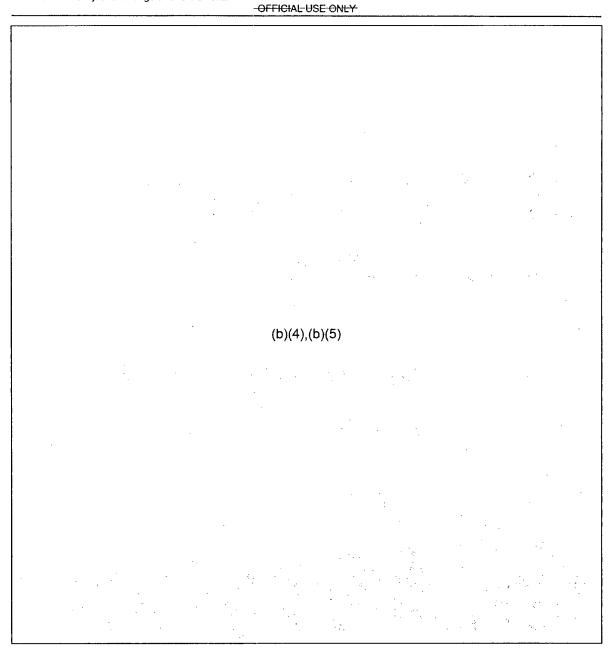


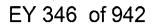
Unit 2 Additional Considerations:

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

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EY 345 of 942





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#### UNIT THREE CORE

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

Core Status:

us: (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)  $\leftrightarrow$  (NISA 4/8); RPV temp: Btm Head 110.8°C $\leftrightarrow$ ; FW nozzle: 88.8°C $\leftrightarrow$  (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  $\leftrightarrow$  (NISA 4/8), torus 73.8 rem/hr  $\leftrightarrow$  (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)	

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# **ASSESSMENT:**

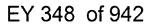
Damaged fuel may have slumped to the bottom of the core and fuel in the lower region of the core is likely encased in salt, however, the amount of salt build-up appears to be less than U-1, based on the reported lower temperatures. Core flow capability is in jeopardy due to continued salt build up.

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.

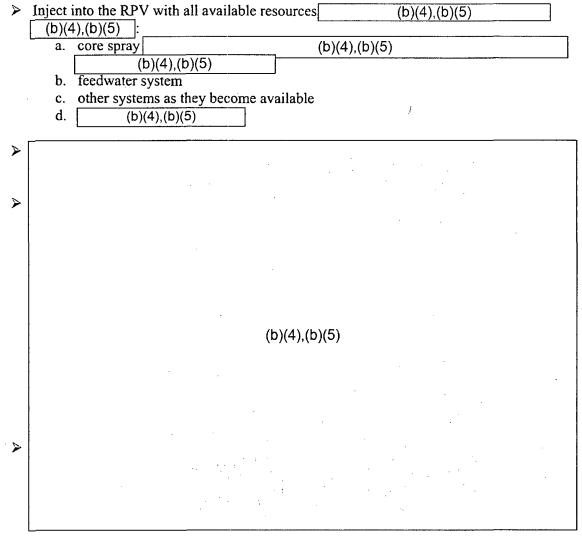
Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material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



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#### **RECOMMENDATIONS:**

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



- > 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)

[Task Tracker 4254] Page 19 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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#### Additional Considerations

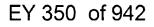
- 1. 2. (b)(4),(b)(5) 3.
- A. The following considerations apply to containment venting:

- 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) HP( instrument taps	CI (b)(4),(b)(5) suction pressure and Dryv
	Radiation monitoring instruments	(b)(4),(b)(5)
). 1.	(b)	(4),(b)(5)

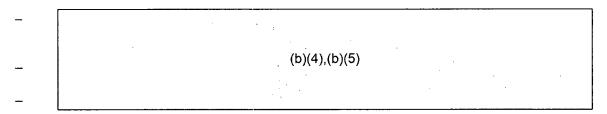


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#### **UNIT 3 - SPENT FUEL POOL STATUS**

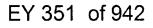
Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data 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)

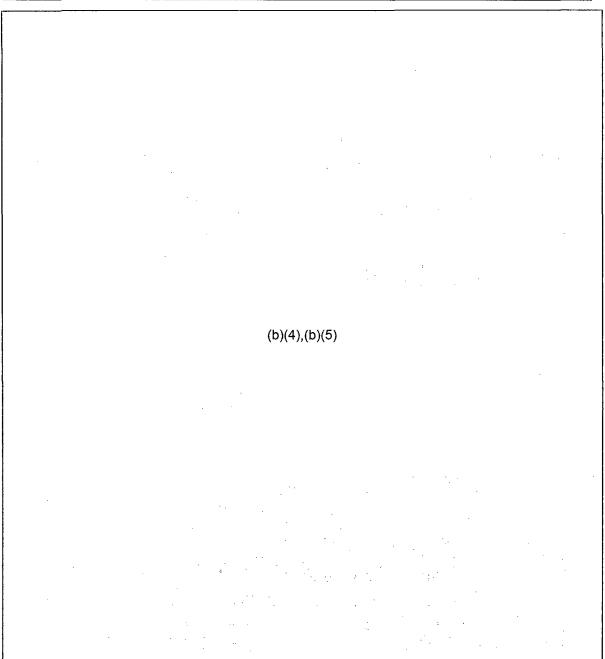
Unit 3 Recommendations:



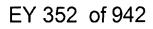
Unit 3 Additional Considerations:

·	(b)(4),(b)(5)	





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# 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)

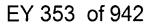
# **ASSESSMENT:**

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.



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#### **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 Lea		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 reacl equipment before energizing	ned the unit, checking electrical integrity of

#### Unit 4 Assessment:

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

#### Unit 4 Recommendations:

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

[Task Tracker 4254] Page 24 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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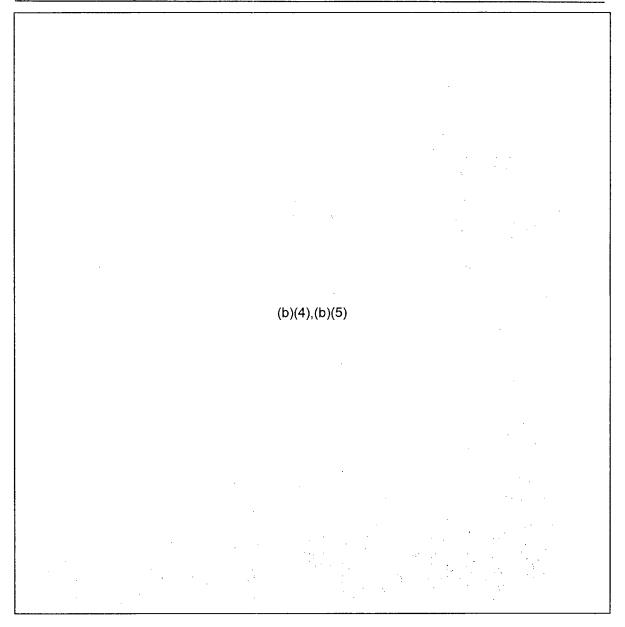
-	
	(b)(4),(b)(5)
-	

Unit 4 Additional Considerations:

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



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[Task Tracker 4254] Page 26 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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#### **UNIT FIVE CORE**

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

Core Status:	(b)(4),(b)(5)	n vessel
	(JAIF, NISA, TEPCO)	
	RPV: pressure .4 psig $\leftrightarrow$ (NISA 4/8); Temp: 45.5°C $\uparrow$ (NISA 4/8);	
Core Cooling	g: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) 3/31);	
Primary Cont	tainment: Functional (JAIF, NISA, TEPCO)	
Secondary Co Vent l	ontainment: hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)	
Spent Fuel Po 946 bi	ool: undles (JAIF); Temp: 34.7oC↓ (JAIF 4/8); Cooling capability recovered (JA	AIF 4/1)
	(b)(4),(b)(5) External AC power supplying the unit, Unit 6 generators available. Fuel Pool Cooling lost when pump failed (JAIF, NIS	• •
TEPC	<u>(b)(4),(b)(5)</u>	]

#### ASSESSMENT:

Unit five is relatively stable.

#### **RECOMMENDATIONS:**

Repairs complete on RHR pump used for fuel pool cooling.

Monitor



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#### **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: Criticality status:	No data No data
Fuel Pool Level:	Full
Fuel Pool Level: Water Injection Method and Source:	Full Fuel pool cooling

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:

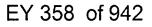
Stable.

Unit 5 Recommendations:

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

Unit 5 Additional Considerations:

<u> </u>			
-	· · · ·	(b)(4),(b)(5)	· · ·



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	(b)(4),(b)(5)	
	(0)(4),(0)(0)	
,		



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# 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)	J
	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 Conta	linment:	
	Functional (JAIF, NISA, TEPCO)	
Secondary Co	ntainment:	
-	Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, T)	EPCO)
Spent Fuel Po	ol:	

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:**

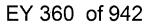
Unit Six is relatively stable.

# **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



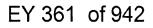
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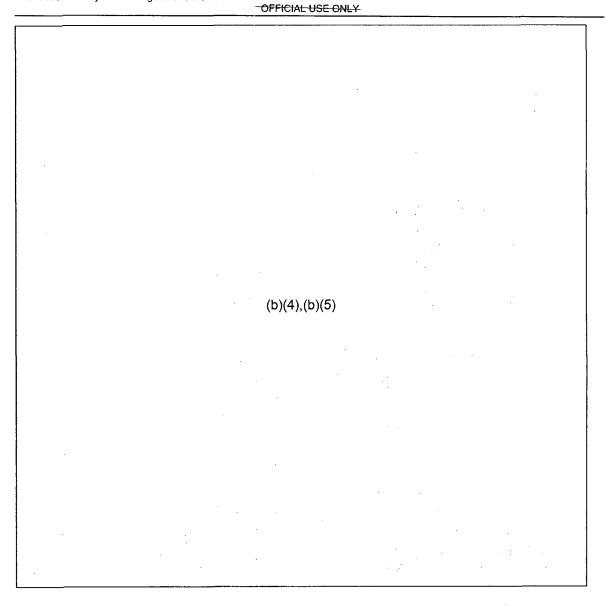
# **UNIT 6 - SPENT FUEL POOL STATUS**

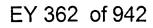
Amount of fuel:	876 bundles
Last transfer from Reactor:	184 bundles (August 10-25 2010)
Decay Heat (MW):	0.7 (MW) (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data Full
Water Injection Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Water Temperature:	28.5°C (TECPO 4/5)
	the unit, Unit 6 diesel generators available. Fuel failed (JAIF, NISA, and TEPCO). Repairs for fuel pool cooling.
Unit 6 Assessment:	
Stable.	
Unit 6 Recommendations:	
-	(b)(4),(b)(5)
Unit 6 Additional Considerations:	

[Task Tracker 4254]Page 31DRAFT - 1200 April 09, 2011M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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







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# **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: Criticality status: Fuel Pool Level:	No data No data 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)			
	<i>i</i>		·	

## **REFERENCES**

- 1. EPRI recommendations March 18, 2011
- 2. SFP Criticality Potential, Kent Wood, March 4, 2011
- 3. Spent Fuel Inventories Document

## **ABBREVIATIONS:**

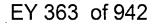
GEH - General Electric Hitachi

**INPO – Institute of Nuclear Power Operations** 

- JAIF Japan Atomic Industrial Forum
- NISA Nuclear and Industrial Safety Agency

[Task Tracker 4254] Page 33 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi





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TEPCO - Tokyo Electric Power Company

**ENCLOSURE 1** 

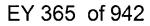
- (b)(4),(b)(5)
- 1. EPRI recommendations March 18, 2011

[Task Tracker 4254] Page 34 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



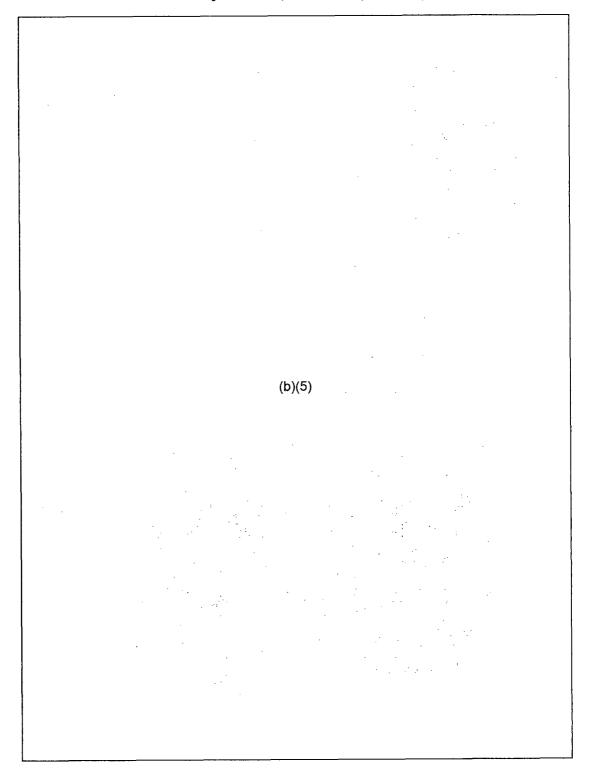
-OFFICIAL-USE-ONLY

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



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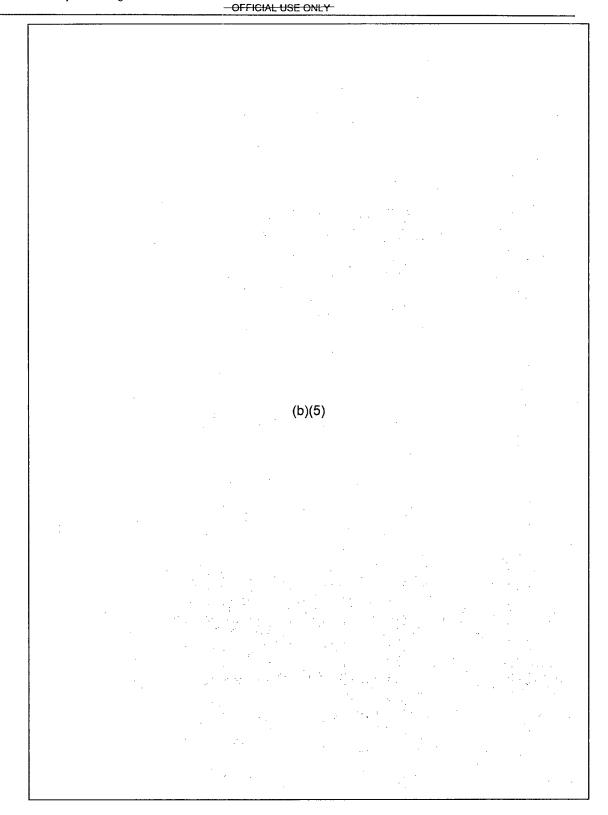
# ENCLSOURE 2



## SFP Criticality Potential, Kent Wood, March 4, 2011

[Task Tracker 4254] Page 36 DRAFT - 1200 April 09, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 366 of 942



EY 367 of 942

#### ----Official Use Only--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

# 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.

# 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	(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
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	<u> </u>	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

From: Sent: To: Subject: Attachments:

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RST01 Hoc Sunday, April 10, 2011 6:44 AM RST06 Hoc FW: Global Assessment 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: <u>Lia08.hoc@nrc.gov</u> Reactor Safety Team: <u>RST01.hoc@nrc.gov</u> Protective Measures Team: <u>Pmt12.hoc@nrc.gov</u>

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 ł

## UNITED STATES NUCLEAR REGULATORY COMMISSION OFFICE OF NEW REACTORS OFFICE OF NUCLEAR REACTOR REGULATION WASHINGTON, DC 20555-0001

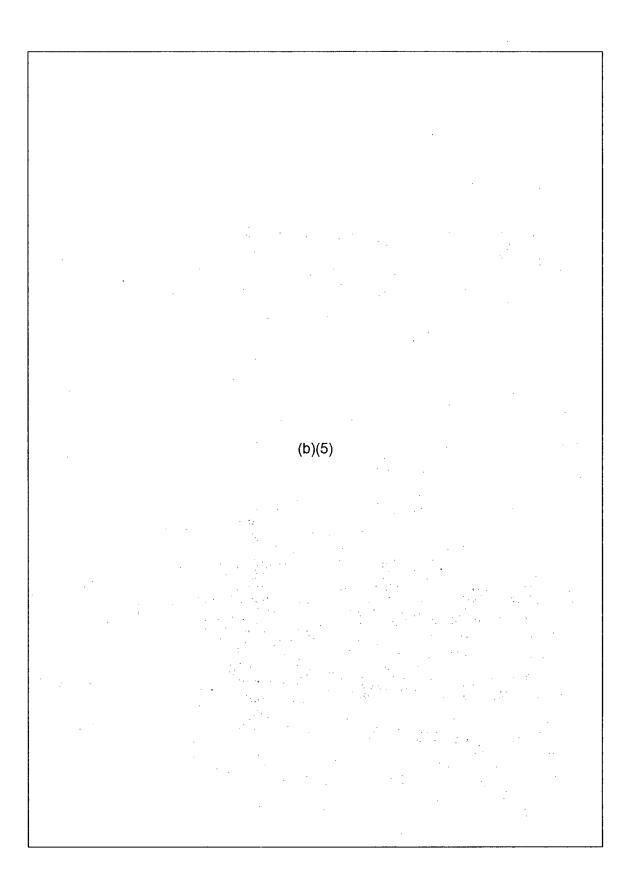
# April XX, 2011

SUBJECT:

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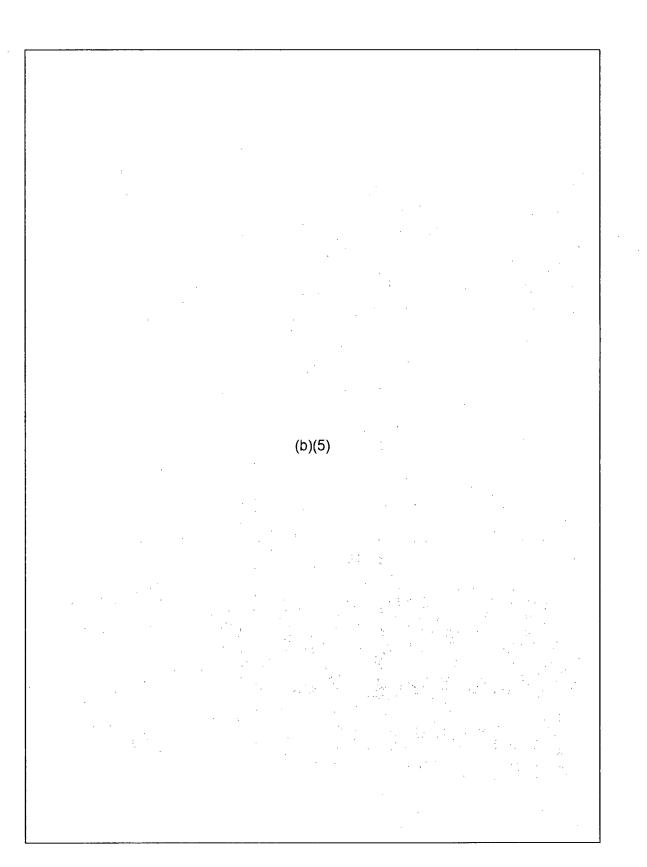
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EY 370 of 942



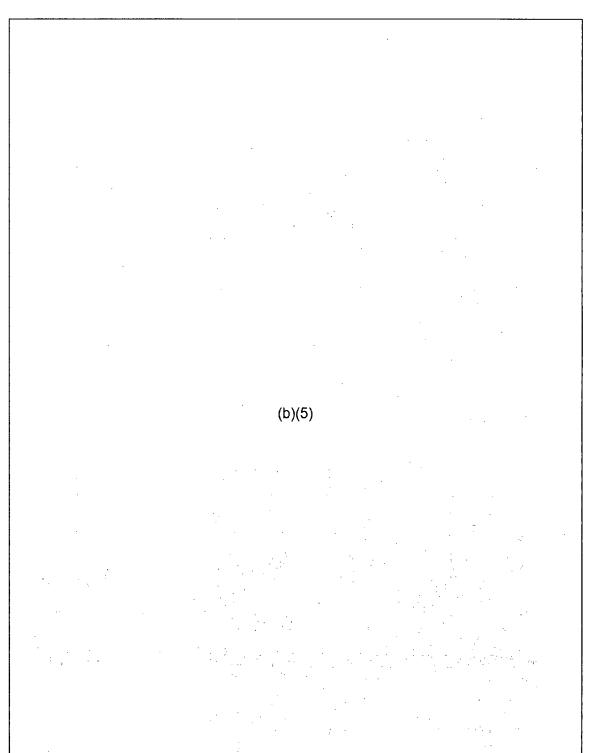
EY 371 of 942

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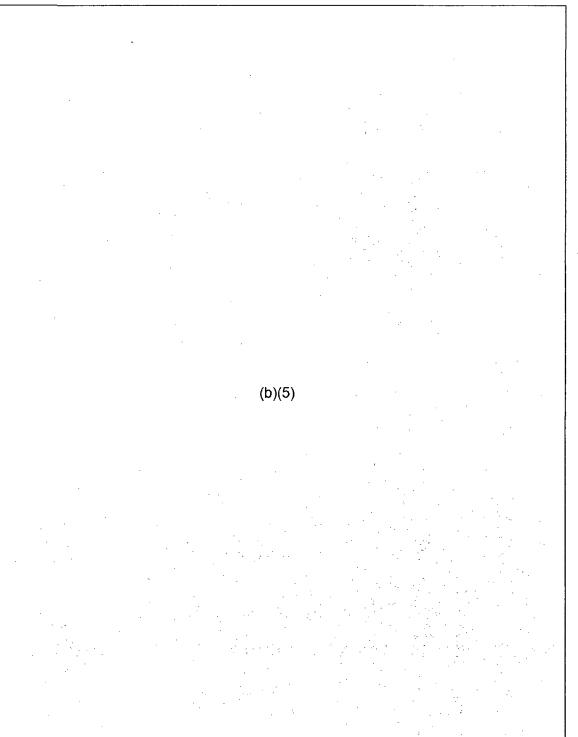


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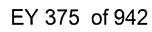
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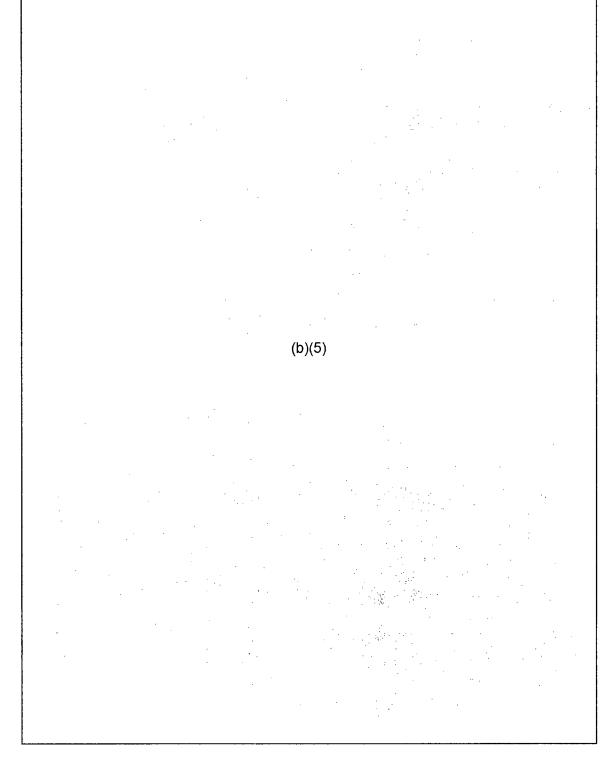


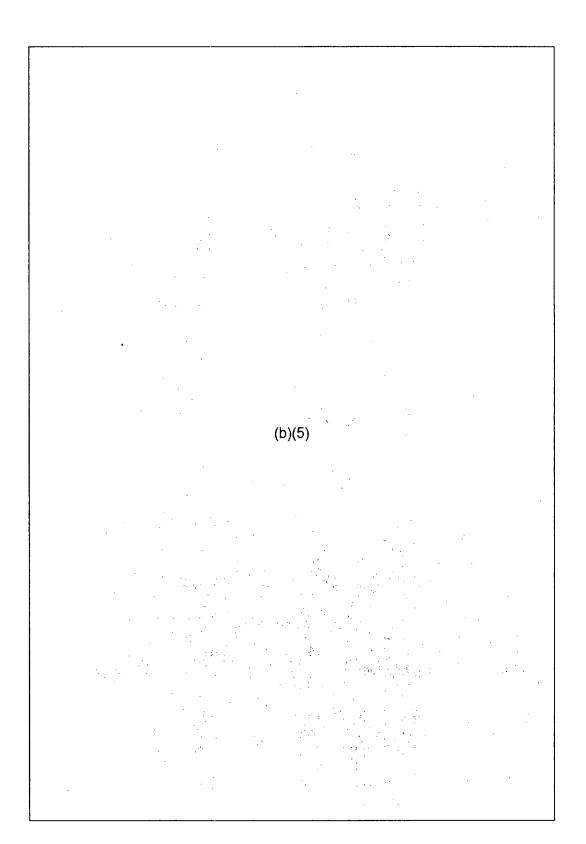
EY 373 of 942



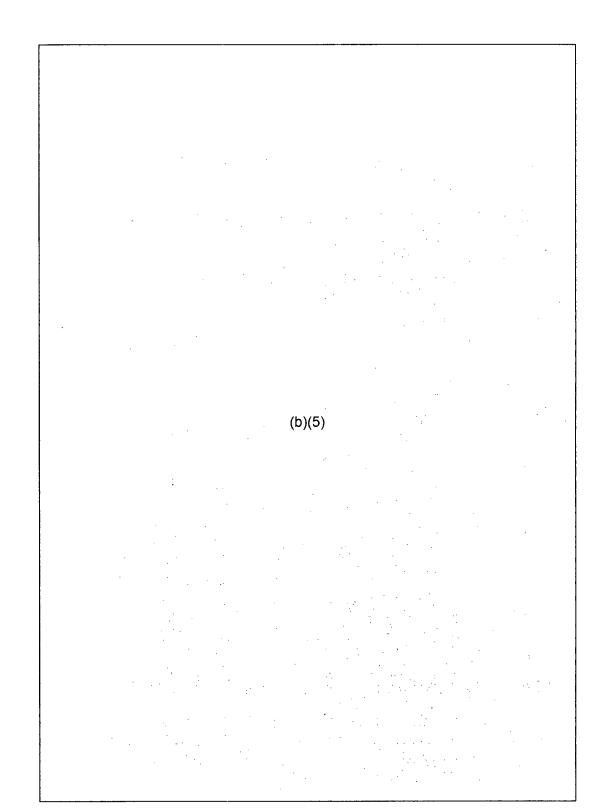
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EY 376 of 942



EY 377 of 942

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EY 378 of 942

(b)(5)

EY 379 of 942

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Fyì...

Flag Status:

From: Hoc, PMT12 Sent: Sunday, April 10, 2011 4:25 AM To: RST02 Hoc Subject: 2011 04-10 global assessment document PMT input

Flagged

PMT input to Global Assessment Document attached.

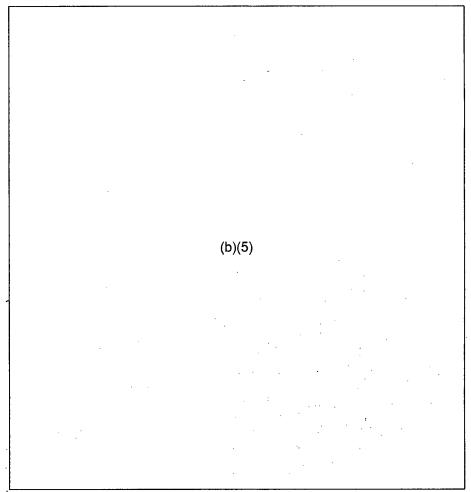
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UNITED STATES NUCLEAR REGULATORY COMMISSION OFFICE OF NEW REACTORS OFFICE OF NUCLEAR REACTOR REGULATION WASHINGTON, DC 20555-0001

April XX, 2011

SUBJECT:

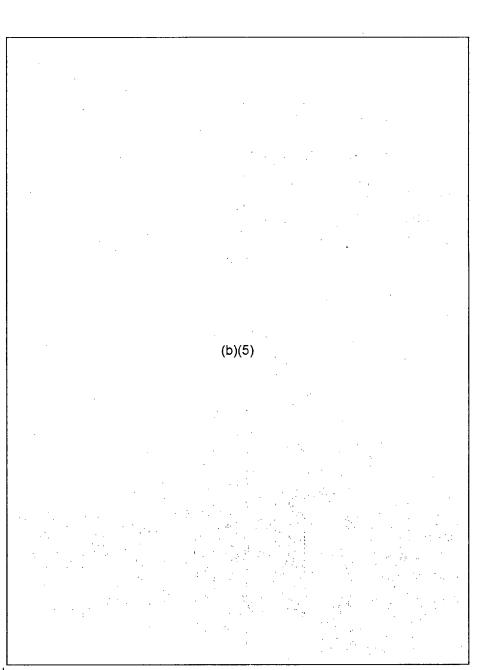
#### NRC RESPONSE TO FUKUSHIMA EVENT



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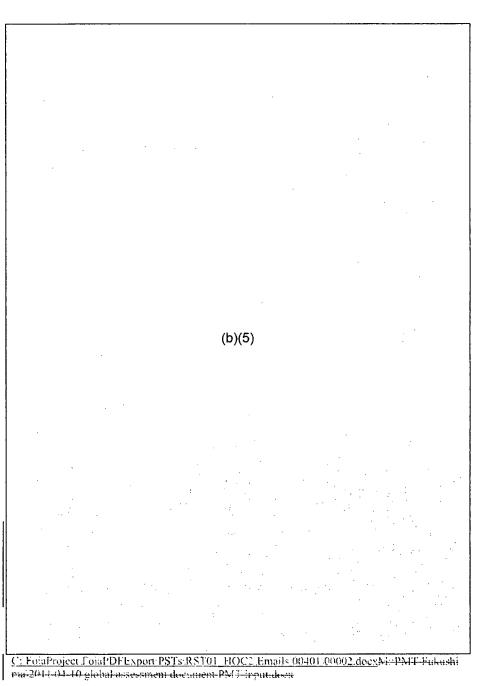
EY 381 of 942

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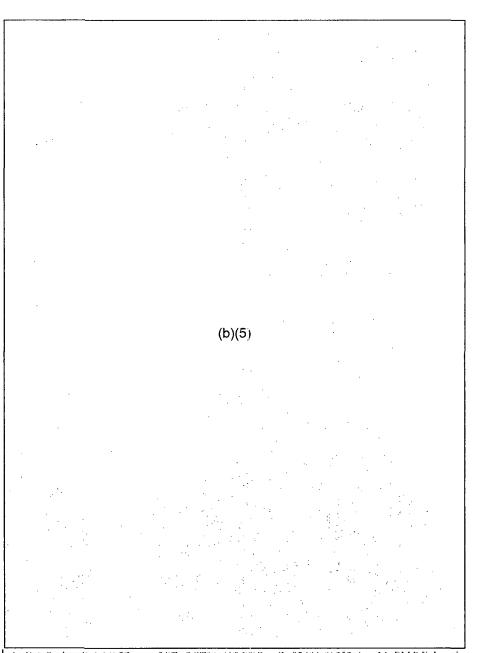


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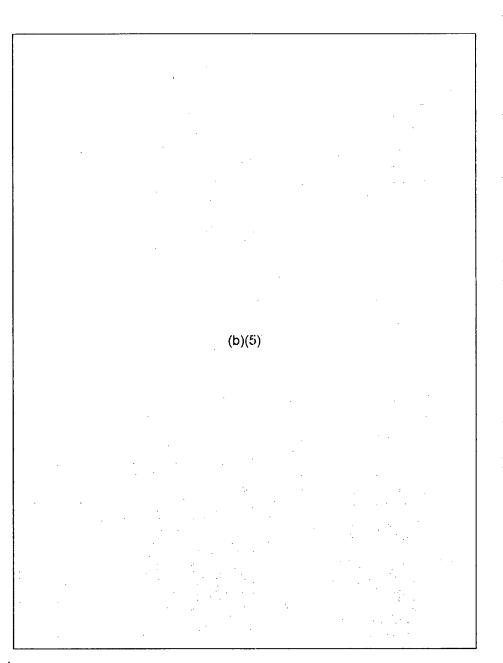


EY 383 of 942



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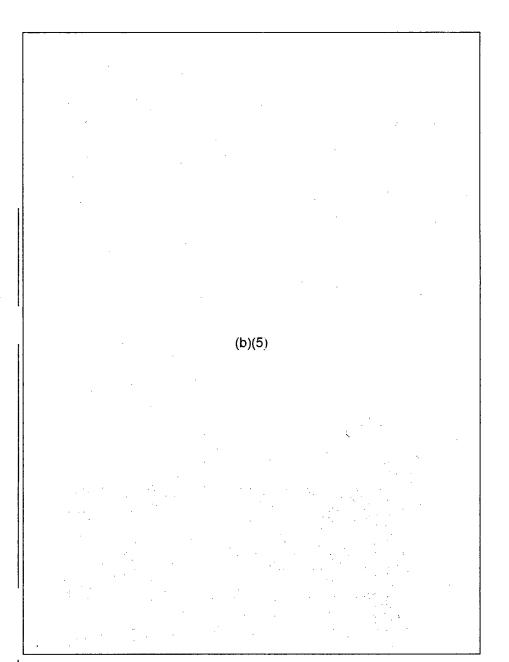
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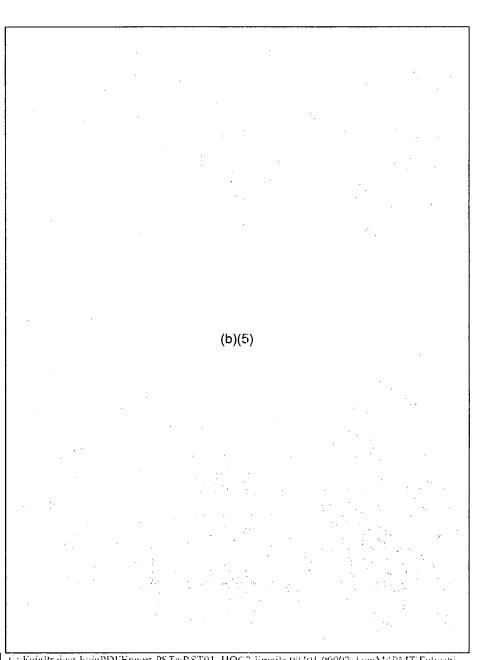
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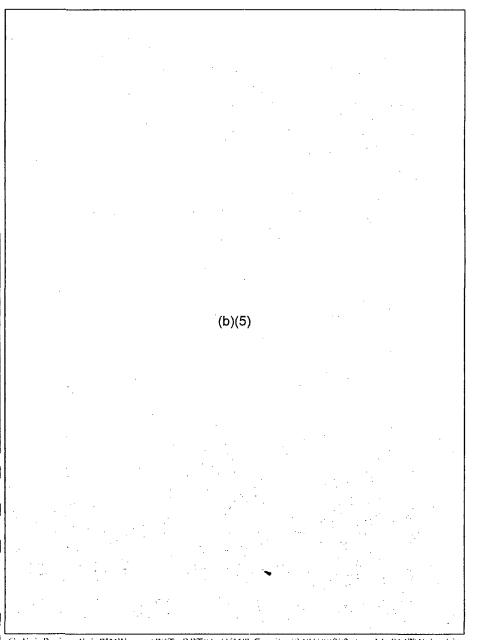
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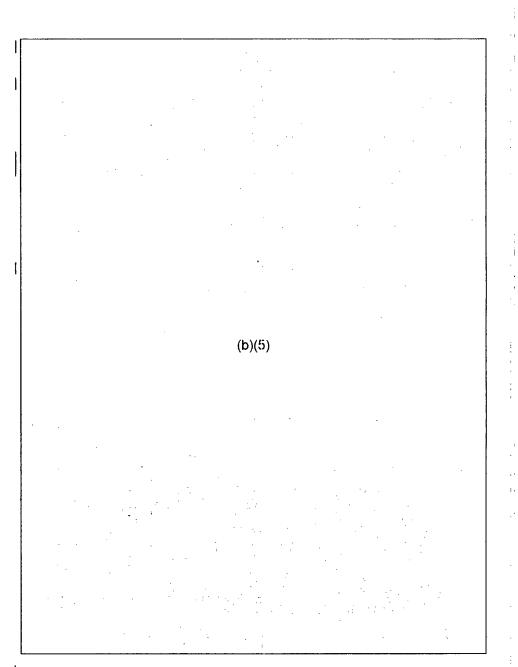
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EY 387 of 942





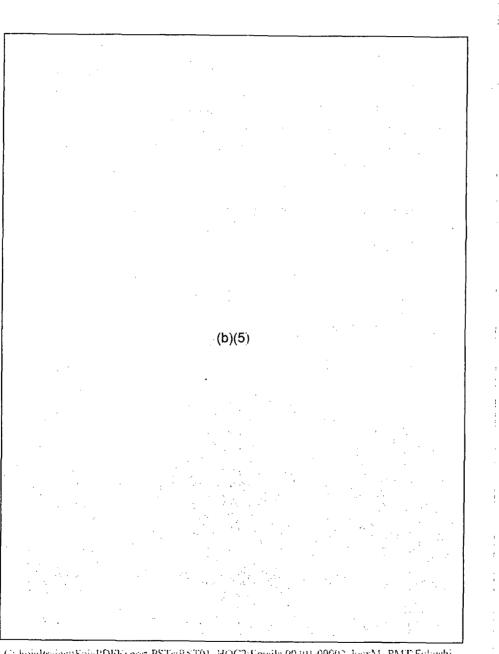
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From: Sent: To:	RST01 Hoc Sunday, April 10, 2011 1:04 AM RST10 Hoc	
Subject:	FW: comments : Global Assessment Document (aka - RST Assessment)	
From: Blamey, Alan		••••
Sent: Sunday, April 10	2011 12:53 AM	
Sent: Sunday, April 10 To: RST01 Hoc	2011 12:53 AM s : Global Assessment Document (aka - RST Assessment)	
Sent: Sunday, April 10 To: RST01 Hoc		
Sent: Sunday, April 10 To: RST01 Hoc	s : Global Assessment Document (aka - RST Assessment)	
Sent: Sunday, April 10 To: RST01 Hoc		

From: Bernhard, Rudolph Sent: Saturday, April 09, 2011 6:50 PM To: Blamey, Alan; Salay, Michael Subject: comments : Global Assessment Document (aka - RST Assessment)

(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)

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1

(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 predecisional document for your review and comments.

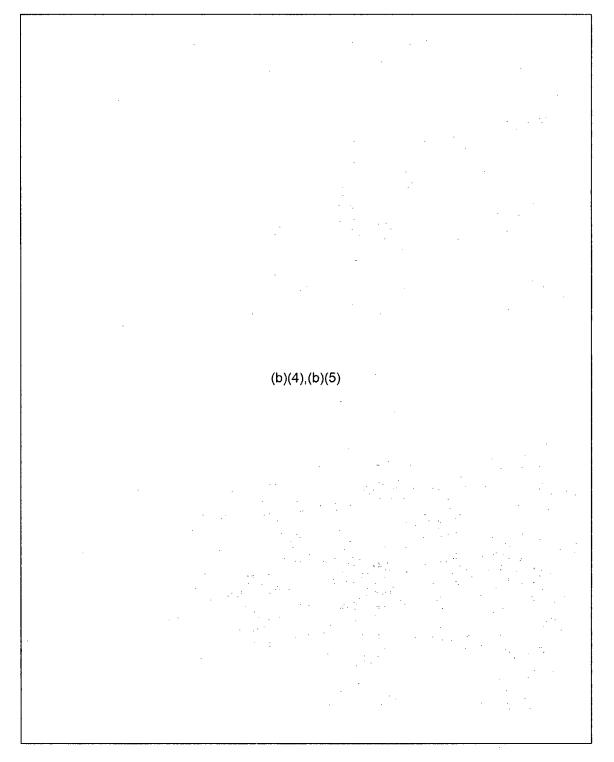
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**RST** Coordinator

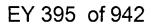
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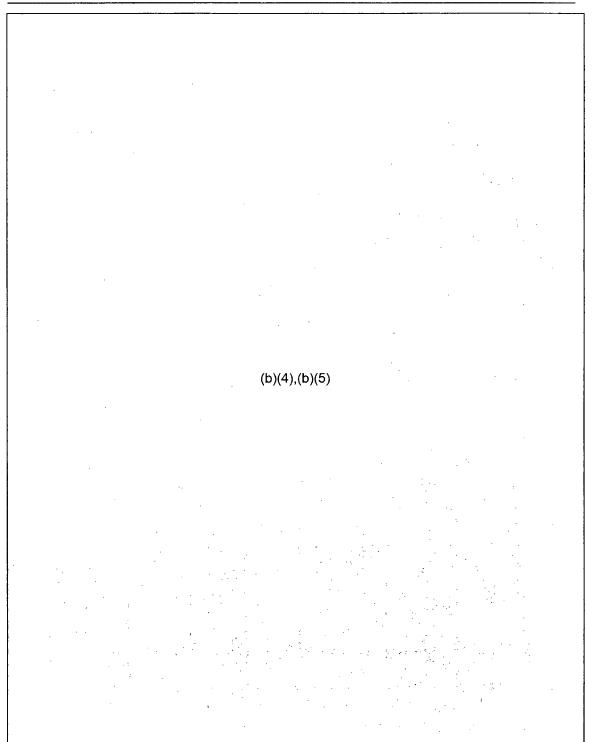
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#### RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2), Based on most recent available data and input from GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE



[Task Tracker 4254] Page 1 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



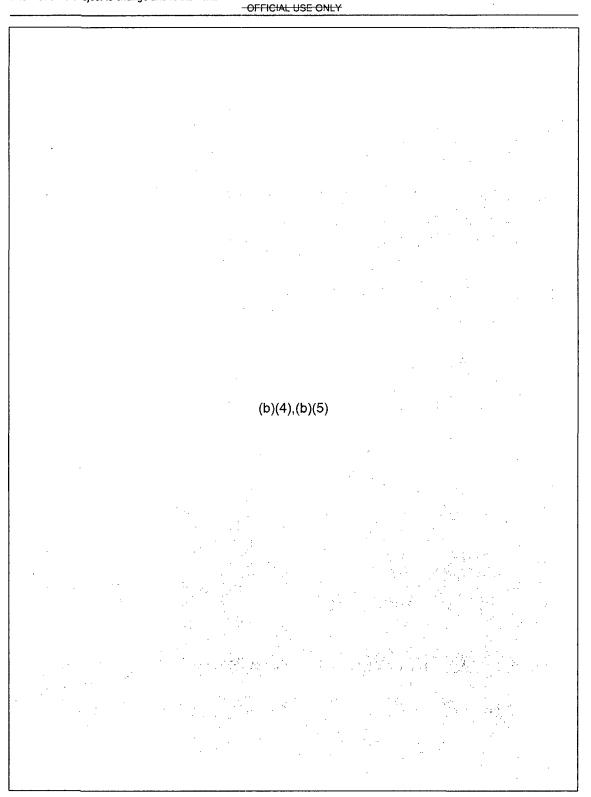


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 Page 2
 DRAFT - 0600 April 10, 2011

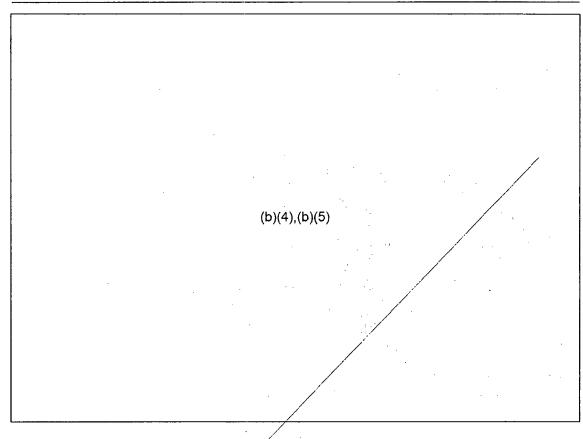
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EY 396 of 942



[Task Tracker 4254] Page 3 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 397 of 942



# 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.

[Task Tracker 4254] Page 4 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 398 of 942

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# 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)

(h)//	\ /h\	15X
(b)(4	),(D)	$(\mathcal{Y})$

(TEPCO); Injection flow rate will be maintained above the MDRIR. Recirculation pump scals 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:

Severely damaged (hydrogen explosion).

Rad levels:DryWell 6830 rem/hr and decreasing (NISA 4/8,(b)(4),(b)(5)(b)(4),(b)(5)(b)(4),(b)(5)(b)(4),(b)(5)(b)(4),(b)(5)Torus 1220 rem/hr and steady (NISA 4/8), Outside plant: 11 mR/hrat gate (variable) (TEPCO 0800 JDT 3/30)

Other: On offsite AC power – Control Room lighting for U-1, 2, 3, & 4 (JAIF, 4/1)

[Task Tracker 4254] Page 5 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 399 of 942

Secondáry Containment:

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) shows entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

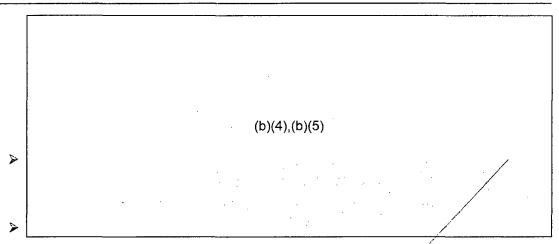
**RECOMMENDATIONS:** (for consideration to stabilize Unit 1)

. n

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

۶	Inject into the RPV with a	Il available resources	·····	7	
		(b)(4),(b)(5)			
			······································		
۶	Nent containment	(b)(4) (b)(5)		$\Box$	
		(b)(4),(b)(5)	(See Additional		
	Considerations A.1. through A.5 below)				
		inment pressure below the prir		mit.	
	b. As necessary to m	aintain RPV injection above M	IDRIR.		
	c. d.	(b)(4),(b)(5)			

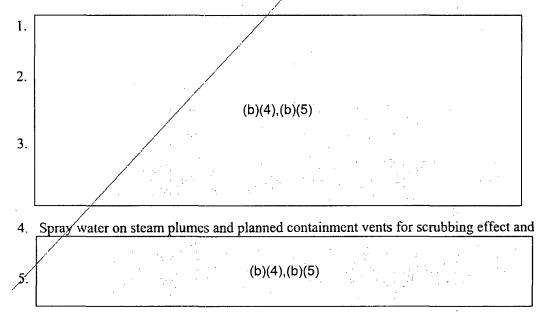




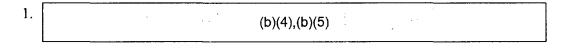
Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

# **Additional Considerations**

A. The following considerations apply to containment venting:



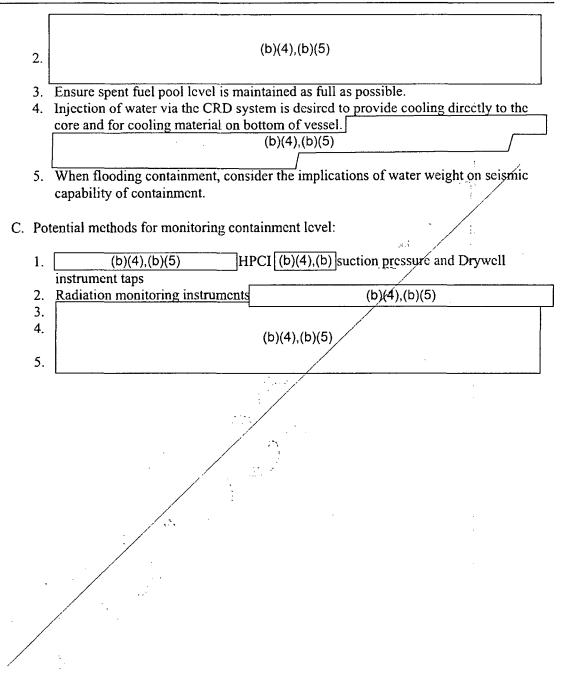
# B. Additional Miscellancous considerations



EY 401 of 942

[Task Tracker 4254] Page 7 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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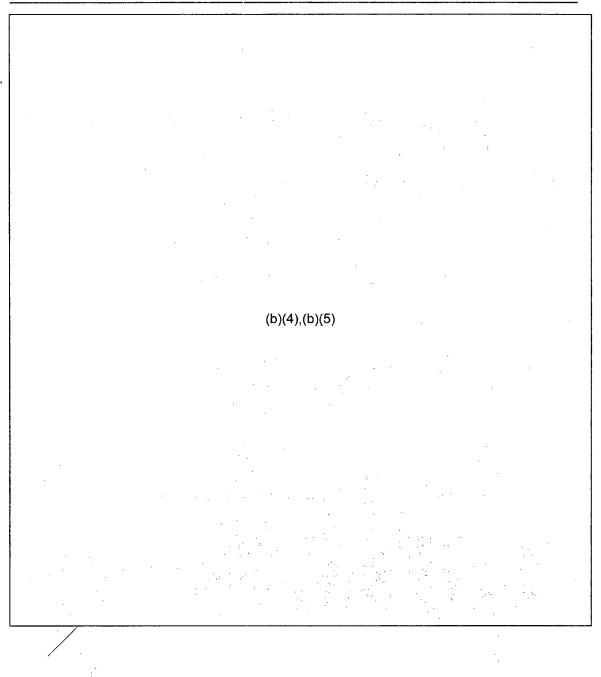




-OFFICIAL-USE-ONLY-UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th) Amount of fuel: 292 bundles Last transfer from Reactor: 64 bundles (March 29 to April 2, 2010) Decay Heat [megawatt thermal (MWth)]: 0.07 MWth, evaporation rate 780 gallons per day Fuel Pool Structural Support Integrity: (b)(4),(b)(5)Fuel 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: ۶ (b)(4),(b)(5)Þ 1/Additional Considerations: Unit (b)(4),(b)(5)

[Task Tracker 4254] Page 9 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 403 of 942



- OFFICIAL-USE ONLY -

[Task Tracker 4254] Page 10 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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# 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°C1 (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 scals 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 $\leftrightarrow$  (NISA 4/8) Secondary Containment: (b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News) Ørywell 2940 rem/hr↓ (NISA 4/8); Torus 77 rem/hr $\leftrightarrow$  (NISA 4/8) Rad Levels: 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)

[Task Tracker 4254] Page 11 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 405 of 942

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### 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.

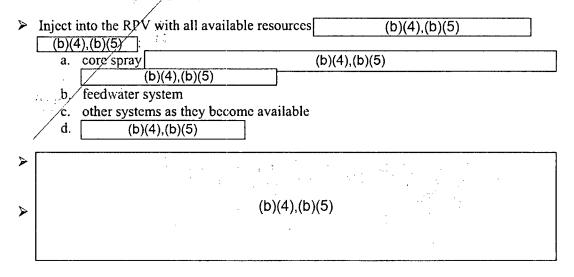
There may be some scrubbing of the release if the release path is through the torus and water level is maintained in the torus.

Fuel pool is heating up (b)(5) but is adequately cooled.

The primary containment is damaged

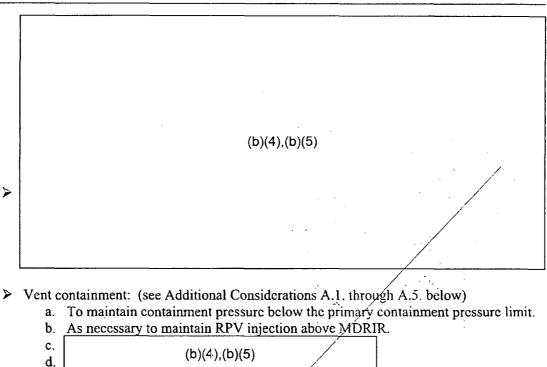
# **RECOMMENDATIONS:**

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



[Task Tracker 4254] Page 12 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

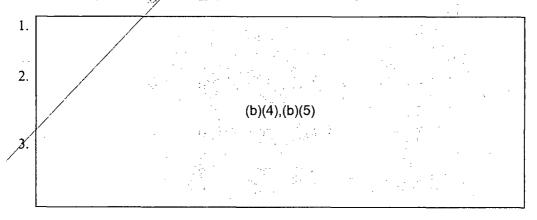
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Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations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

# **Additional Considerations**

A. The following considerations apply to containment venting:



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

[Task Tracker 4254] Page 13 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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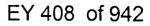
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5.

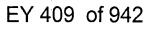
(b)(4),(b)(5)

- 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)

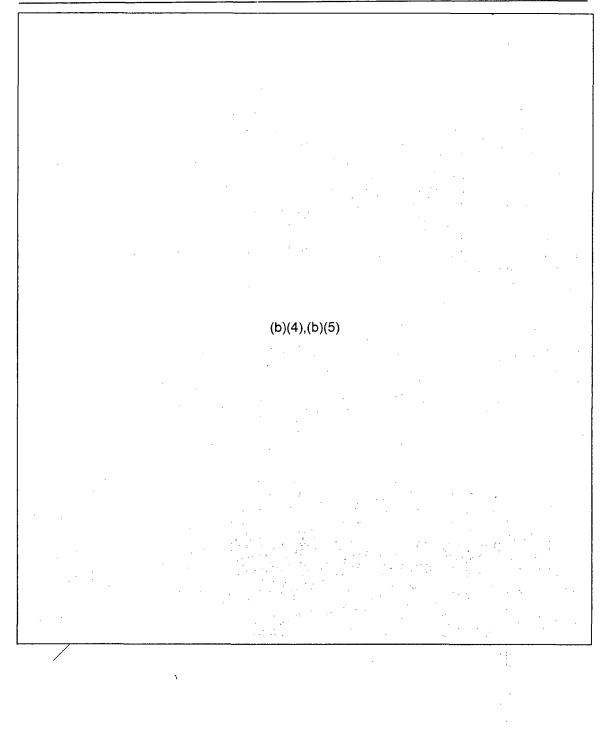
La.	(b)(4),(b)(5)    HPCI (b)(4),(b)(5)
а.	instrument taps
b.	Radiation monitoring instruments (b)(4),(b)(5)
с.	
d.	(b)(4),(b)(5)
e.	
	· · / ·
/	
/	



-OFFICIAL USE ONLY **UNIT 2 - SPENT FUEL POOL STATUS** 587 bundles Amount of fuel: 116 bundles (September 20-25, 2010) Last transfer from Reactor: Decay Heat [megawatt thermal (MWth)]: 0.47 MWth; evaporation ration rate 5240 gallons per day (b)(4),(b)(5 Fuel Pool Structural Support Integrity: No data Fuel Pool Leak Integrity: No data Criticality status: Full ((b)(6) 4/3) Fuel Pool Level: 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) External AC power has reached the unit, checking the integrity of equipment Other: 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)



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[Task Tracker 4254] Page 16 DRAFT - 060 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

DRAFT - 0600 April 10, 2011

EY 410 of 942

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# 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 psig1, ch B= -11.4 psig)  $\leftrightarrow$  (NISA 4/8); RPV temp: Btm Head 110.8°C $\leftrightarrow$ ; FW nozzle: 88.8°C $\leftrightarrow$  (NISA 4/8)

Core Cooling: Freshwater injection 30.8 gpm↔ (NISA 4/8) via fire ext. line using temp. clect pump (b)(6) 4/5), Recirculation pump seals have likely failed.

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

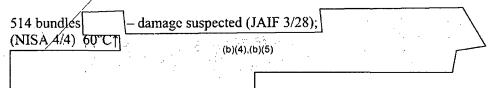
Damage suspected (RST, NISA, TEPCØ) "Not damaged" (JAIF 10:00 3/25)

Drywell pressure 0.6  $psig \leftrightarrow (NISA 4/8)$ , Torus pressure 10.3  $psig \leftrightarrow (NISA 4/8)$ 

Secondary Containment

Damaged (JAIF, NISA, TEPCO). (b)(4),(b)(5) May begin to inject nitrogen gas (NHK World News)

Spent Fuel Pool



Rad Levels. DW 1880 rcm/hr  $\leftrightarrow$  (NISA 4/8), torus 73.8 rcm/hr $\leftrightarrow$  (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)	-		

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# 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 scals, 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.

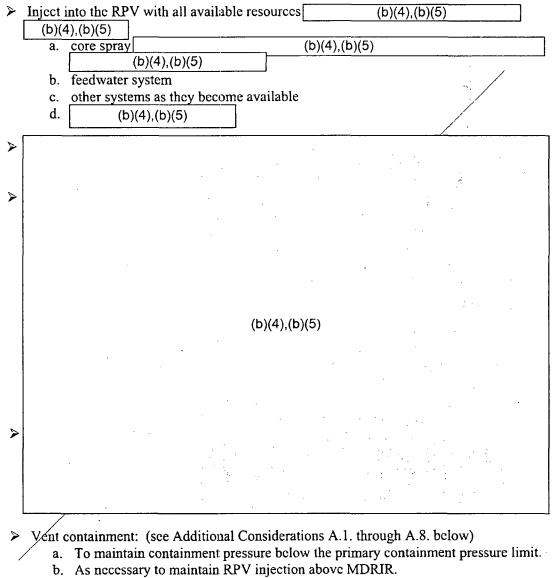
Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very high dose rate material that had to be bulldozed over between Units 3 and 4. It is also possible the material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

EY 412 of 942

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# **RECOMMENDATIONS:**

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



- c. (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)

[Task Tracker 4254] Page 19 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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# **Additional Considerations**

- 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. (b)(4),(b)(5)C. Potential methods for monitoring containment level. (b)(4),(b)(5)(b)(4),(b)(5)HPCI suction pressure and Drywell a. (b)(4),(b)(5) instrument taps b. Radiation monitoring instruments (b)(4).(b)(5) c. (b)(4),(b)(5) d.
- A. The following considerations apply to containment venting:

[Task Tracker 4254] Page 20 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 414 of 942

# UNIT 3 - SPENT FUEL POOL STATUS Amount of fuel: 514 bundles

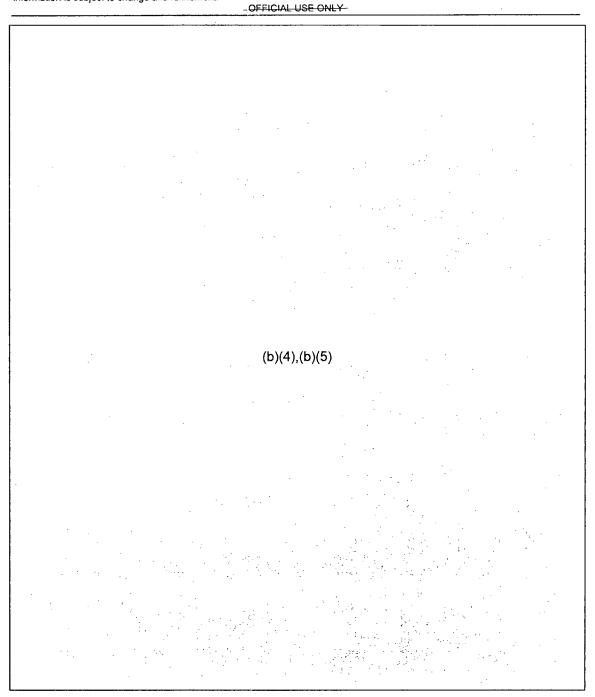
Last transfer from Reactor: 148 bundles (June 23 to 28, 2011) Decay Heat (MWth): 0.23 MWth; evaporation rate 2570 gallons per day Damage suspected (JAIF 3/28); Fuel Pool Structural Support Integrity: (b)(4),(b)(5) (b)(4),(b)(5)Fuel Pool Leak Integrity: No data Criticality status: No data Fuel Pool Level: Full(b)(6)4/3) Periodic fresh water injected via a hose off of a Water Injection Method and Source: concrete pumper truck arm 57°C (JAIF 4/6) Fuel Pool Water Temperature: Other: 13 Unit 3 Assessment: (b)(4),(b)(5) Unit 3 Recommendations: (b)(4),(b)(5)

Unit 3 Additional Considerations:

-	(b)(4),(b)(5)	·		· · · · · ·
			:	

[Task Tracker 4254] Page 21 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 415 of 942



[Task Tracker 4254] Page 22 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 416 of 942

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# 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. At is also possible the material could have come from Unit 3).

# **RECOMMENDATIONS:**

(b)(4),(b)(5)
 As possible, put spent fuel cooling and cleanup in service.

- OFFICIAL USE ONLY **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 Damage suspected (JAIF 3/28); (b)(4),(b)(5) Fuel Pool Structural Support Integrity: (b)(4),(b)(5)No data Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level: Low water level (b)(6) 4/1) Periodic fresh water injected via a hose off of a Water Injection Method and Source: concrete pumper truck arm (38 tons of water added on 4/7/11) 57°C (JAIF 4/4) Fuel Pool Water Temperature: Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing. Unit 4 Assessment: (b)(4),(b)(5)

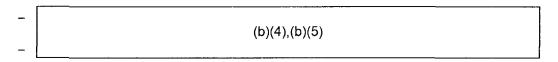
Unit 4 Recommendations:

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

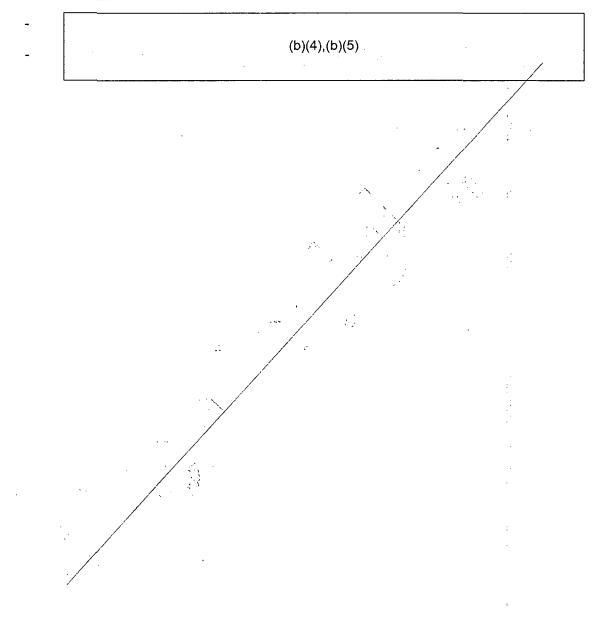
[Task Tracker 4254] Page 24 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichì

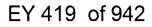
EY 418 of 942

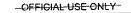
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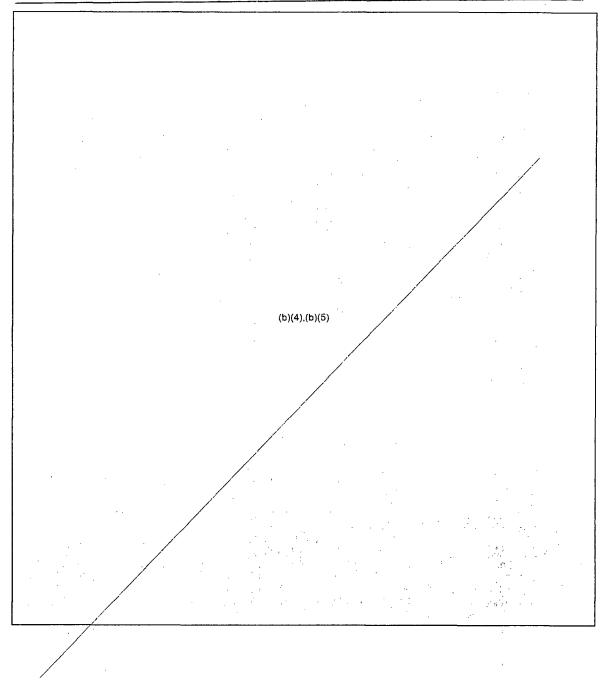


# Unit 4 Additional Considerations:









[Task Tracker 4254] Page 26 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

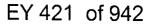


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# **UNIT FIVE CORE**

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: $45.5^{\circ}C\uparrow$ (	NISA 4/8);	
Core Cooling	: Functional (JAIF, NISA, TEPCO); (b)( 3/31);	4),(b)(5)	
·	ainment: Functional (JAIF, NISA, TEPCO)		
Secondary Co Vent l	ontainment: nole drilled in rooftop to avoid hydrogen build up (JAIF,	NISA, TEPCO)	
Spent Fuel Po 946 bi	ool: undles (JAIF); Temp: 34.7oC↓ (JAIF 4/8); .Cöoling capat	oility 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)		
ASSESSME	NT:		
Unit five is re	elatively stable.		
RECOMME	NDATIONS:		
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)

Not damaged (JAIF 4/4)

Fuel Pool Structural Support Integrity:

Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level: No data No data Full

Water Injection Method and Source:

Fuel Pool Water Temperature: 37.9

37.9°C (JAIF 4/5)

Fuel pool cooling

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:

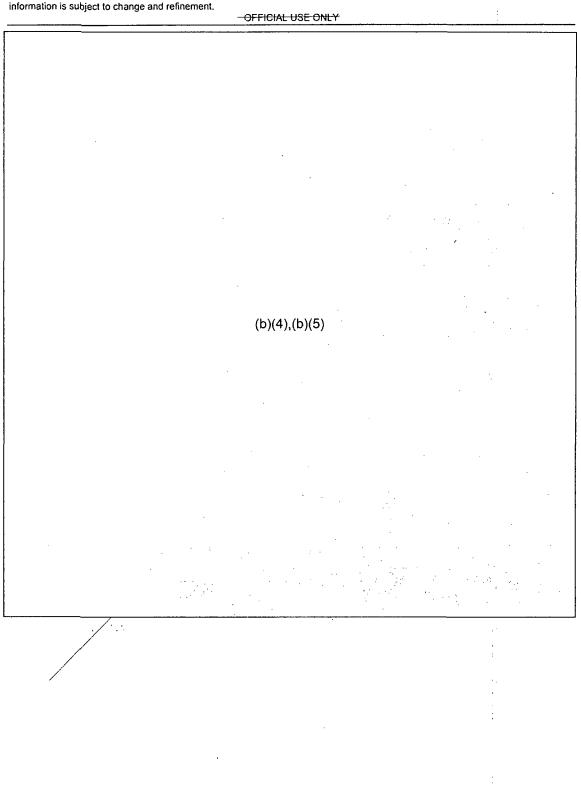
Stable.

Unit 5 Recommendations:

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

Unit 5 Additional Considerations:

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



[Task Tracker 4254] Page 29 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 423 of 942

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# 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 $\leftrightarrow$ (NISA 4/8); Temp: 22.7°C $\leftrightarrow$ (NISA 4/8);	
Core Cooling:	Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5)	
Primary Conta	ainment: Functional (JAIF, NISA, TEPCO)	
Secondary Co	ntainment: Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NIS)	A, TEPCO)
Spent Fuel Pe	ool: 876 bundles (b)(6) Temp: 30.5.0°C↑ (NISA 4/8); Cooling capabil (JAIF 4/1). Fuel pool cooling functioning.	ity recovered
Other:	(b)(4),(b)(5)	
ASSESSME	NT:	
Unit Six is re	latively stable.	
RECOMM	ENDATIONS:	:
1. Moni	tor	:
ABBREVIA	TIONS:	
INPÓ – Insti JAIF – Japan NISA – Nuc	eral Electric Hitachi tute of Nuclear Power Operations A Atomic Industrial Forum lear and Industrial Safety Agency okyo Electric Power Company	

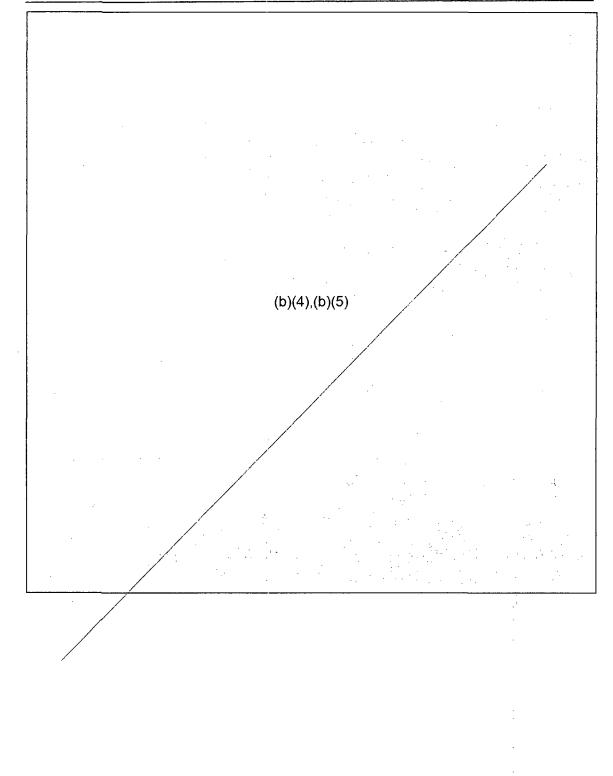
EY 424 of 942

# **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: Criticality status: Fuel Pool Level:	No data No data 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 supplyin Pool Cooling lost when pur complete on RHR pump use	ng the unit, Unit 6 diesel generators available. Fuel np failed (JAIF, NISA, and TEPCO). Repairs ed for fuel pool cooling.
Unit 6 Assessment:	
Stable.	
-	(b)(4),(b)(5)
Unit 6 Additional Considerations:	
	(b)(4),(b)(5)

[Task Tracker 4254] Page 31 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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[Task Tracker 4254] Page 32 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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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: Criticality status: Fuel Pool Level:	No data No data Full		
Water Injection Method and Source:	Normal cooling (NISA 3/24)		
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)		
Other:	50		
Common SFP Assessment:			
Relatively stable.			
Common SFP Recommendations:			
-	(b)(4),(b)(5)		
Common Additional Considerations:			
	(b)(4),(b)(5)		
REFERENCES			
<ol> <li>EPRI recommendations March 18, 2011</li> <li>SFP Criticality Potential, Kent Wood, March 4, 2011</li> <li>Spent Fuel Inventories Document</li> </ol>			
ABBREVIATIONS:			
GEH – General Electric Hitachi INPO – Institute of Nuclear Power Operatio JAIF – Japan Atomic Industrial Forum NISA – Nuclear and Industrial Safety Agene			

[Task Tracker 4254] Page 33 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 427 of 942

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TEPCO - Tokyo Electric Power Company

**ENCLOSURE 1** 

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

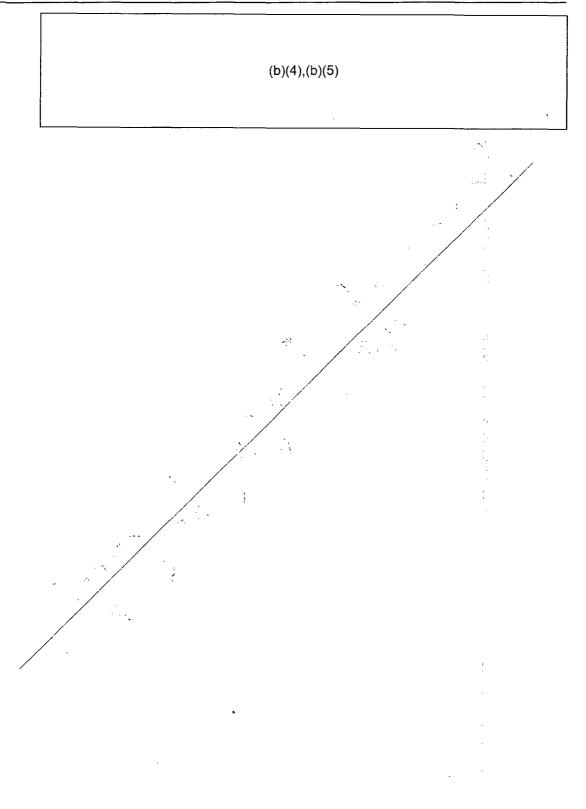
# 1. EPRI recommendations March 18, 2011

 Page 34
 DRAFT - 0600 April 10, 2011

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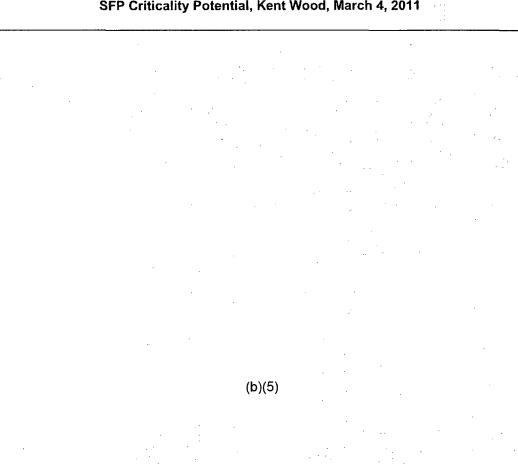
[Task Tracker 4254] Page 35 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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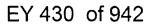
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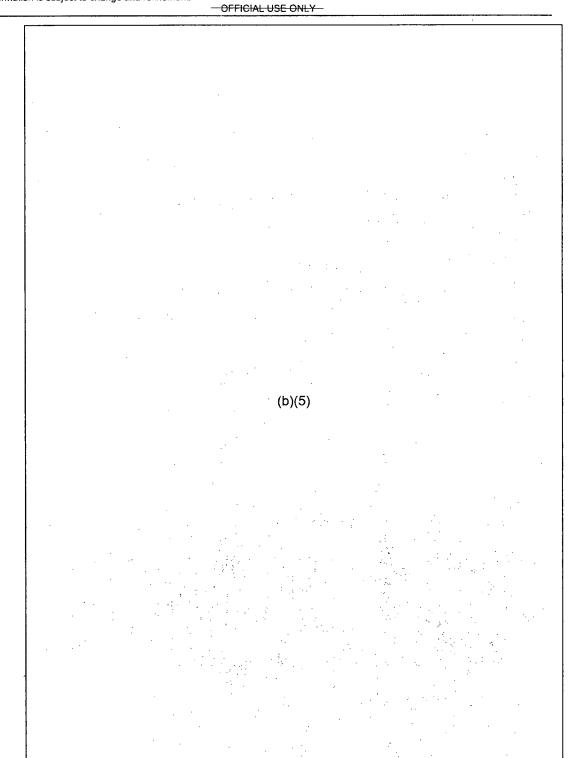
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[Task Tracker 4254] Page 37 DRAFT - 0600 April 10, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 431 of 942

### -Official Use Only-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

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.

## 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		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

T	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.

EY 432 of 942

## Esmaili, Hossein

From: Sent: To: Subject: Attachments: Esmaili, Hossein Monday, April 11, 2011 8:18 AM Notafrancesco, Allen FW: Nitrogen injection graph Nitrogen curve img-409154535.pdf

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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 cēll (b)(6) gardla@inpo.org

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EY 433 of 942

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From: Sent: To: Subject: Attachments:

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RST01 Hoc Monday, April 11, 2011 12:06 AM RST08 Hoc; RST07 Hoc; RST06 Hoc FW: Marked up Spent Fuel Pools doc 04-07-11 2000 RST Assessment Spent Fuel PoolJSTmods.docx

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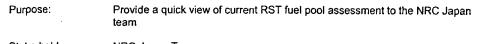
From: Salay, Michael Sent: Monday, April 11, 2011 12:04 AM To: RST01 Hoc Subject: FW: Marked up Spent Fuel Pools doc

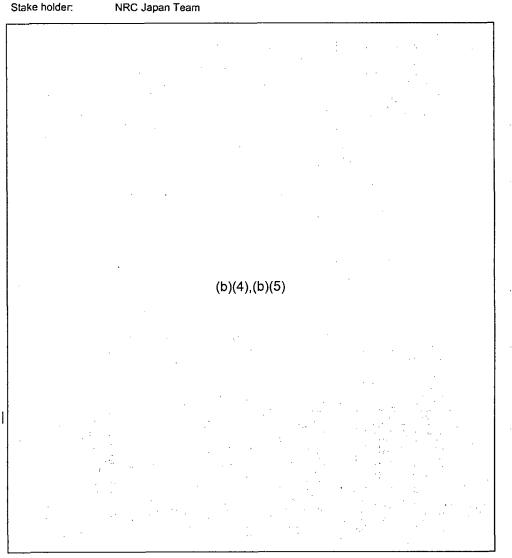
Japan Team RSST comments on the SFP paper "General Discussion of the Desired End State of all Spent Fuel Pools" attached. Note that these comments were made to the next to last version.

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



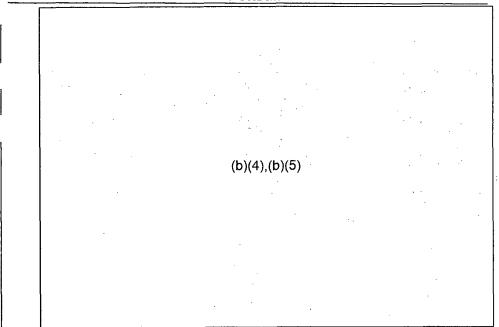


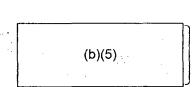
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The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical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

SPENT FUEL POOL STATUS (1400 April 6th)

<u>Fukushima Da</u>	aiichi 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	(	(b)(5)
Fuel Pool Structural Support Integrity:		(b)(4),(b)(5)		
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:		No data No data 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	l	
		(b)(4),(b)(5)		

Unit 1 Assessment:

	(b)(4),(b)(5)		
Unit 1 Recommendations:			
-	(b)(4),(b)(5)		
Unit 1 Additional Consideration	<u>s:</u>	 (b)(5)	
-	(b)(4),(b)(5)	ted' Fant: 9 at Do not check so	

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<u>kushima Daiichi Unit 2</u>	·			
ount of fuel:	587 bundles			
st transfer from Reactor:	116 bundles (September 20-25, 2010)			
cay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation ration rate 5240 gallons per day	(	(b)(5)	
el Pool Structural Support Integrity:	(b)(4),(b)(5)			
el Pool Leak Integrity:	No data	۶. ۱		
ticality status: el Pool Level:	No data Full (b)(6) [3)			
ter Injection Method and Source:	Fresh water injected to the spent fuel pool	•		
el Pool Water Temperature:	71°C (TEPCO 4/5)			
	ched the unit, checking the integrity of equipment before			
energizing.	(b)(4),(b)(5)			
it 2 Assessment:				
	(b)(4),(b)(5)			
-				
it 2 Recommendations:				
-				
_	(b)(4),(b)(5)			
-	· · · · · · · · · · · · · · · · · · ·			
t 2 Additional Considerations:			(b)(5)	
	(b)(4),(b)(5)			<sup>-</sup>

The purpose of this document is to provide the NRC Read Spent Fuel Pools to the USNRC team in Japan. Our asso information. We acknowledge that the information is subj	cor Safety Team's assessment and recommendations for the Fukushima-Daiichi essments and recommendations are based on the best available technical ect to change and refinement. "OFFICHAL USI: ONLY-			
Fukushima Daiichi Unit 3		1		
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			(b)(5)	
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28) (b)(4),(b)(5) (b)(4),(b)(5)			
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data 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:				
Other:				
Unit 3 Assessment:				
· · · · · · · · · · · · · · · · · · ·	(b)(4),(b)(5)	:		
Unit 3 Recommendations:		÷		
-				
	(b)(4),(b)(5)			
-		:		
Unit 3 Additional Considerations			(b)(5)	
-	(b)(4),(b)(5)	L		

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Jnit <u>4 Recon</u>	nmendations:				
	······································	· · · · · · · · · · · · · · · · · · ·			
•••					
			۹ : :		
			-		
		(b)(4),(b)(5)	: .		
	· · · ·		I.		
Jnit 4 Asses	<u></u>				
1	before energizing.				
ther:		eached the unit, checking electrical integrity of equipment			
uel Pool W	ater Temperature:	pumper truck arm 30°C (JAIF 4/4)			
Vater Injecti	on Method and Source:	Periodic fresh water injected via a hose off of a concrete			
-uel Pool Le Criticality sta Fuel Pool Le		No data <u>No data</u> Low water level (b)(6) 4/1)			
,		(b)(4),(b)(5)			
	ructural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5)		(b)(5)	3
Last transier Decay Heat	from Reactor:	548 bundles (December 5 to December 10, 2010)	· 		
Amount of fu		1331 bundles			
			• •		
<u>Fukushima I</u>	Doliobi Unit 4				

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-	(b)(4)	,(b)(5)			
<u>Unit 4</u>	Additional Consid	erations:			
-		·. ·.	(b)(4),(b)(5)	s .	

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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. -OFFICIAL USE: ONLY-

Fukushima Daiichi Unit 5 Amount of fuel: 946 bundles Last transfer from Reactor: 120 bundles (January 8-13, 2011) (b)(6) Decay Heat (MW): 0.8 MW (b)(4),(b)(5) Not damaged (JAIF 4/4) Fuel Pool Structural Support Integrity: 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) .....

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Fukushima Dalichi 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)		(b)(5)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)		
Fuel Pool Leak Integrity: Criticality status; Fuel Pool Level:	No data No data 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 supplyi Cooling lost when pump fa pump used for fuel pool co	ng the unit, Unit 6 diesel generators available. Fuel Pool iled (JAIF, NISA, TEPCO). Repairs complete on RHR oling.		
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: Criticality status: Fuel Pool Level:	No data No data 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 SEP 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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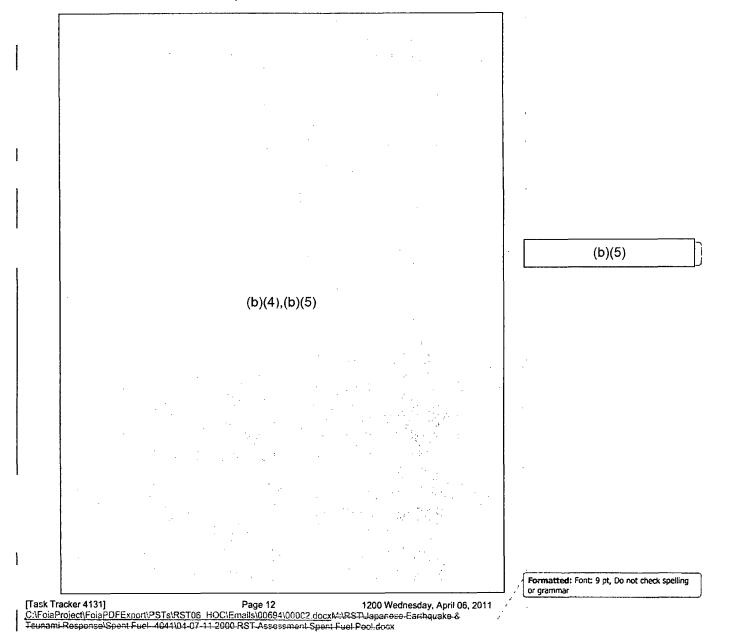
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The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daiichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement. -OFFICIAL USE-ONLY-



1. EPRI recommendations March 18, 2011



EY 448 of 942

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

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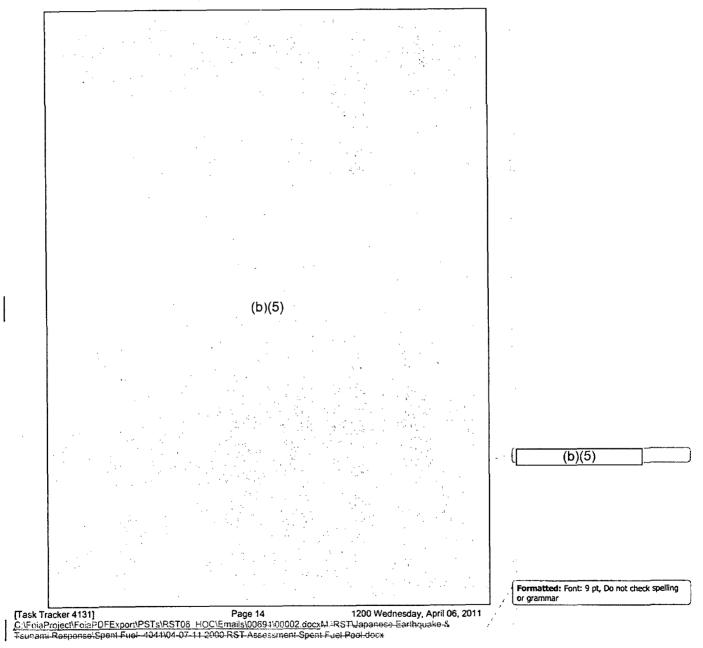
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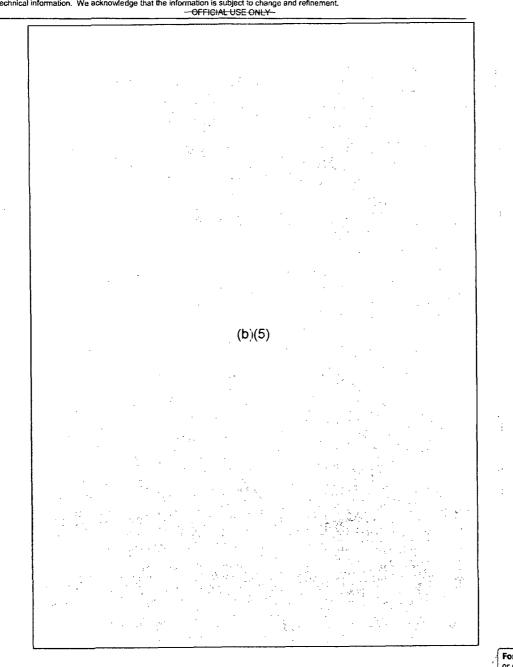
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## ENCLSOURE 2





EY 450 of 942



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### 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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EY 452 of 942

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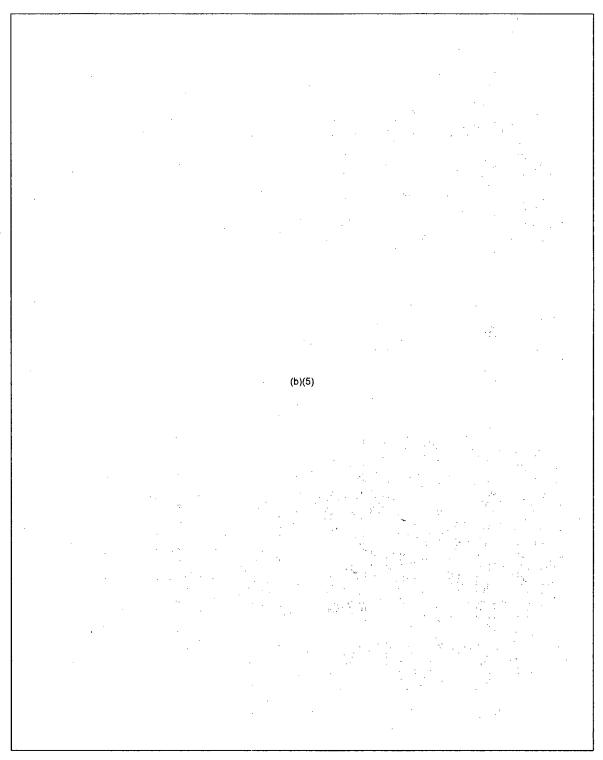
From: Sent: To: Subject: Attachments:

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Hoc, PMT12 Monday, April 11, 2011 1:00 PM OST01 HOC FW: PARs for Deputies Meeting Rev 16 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.

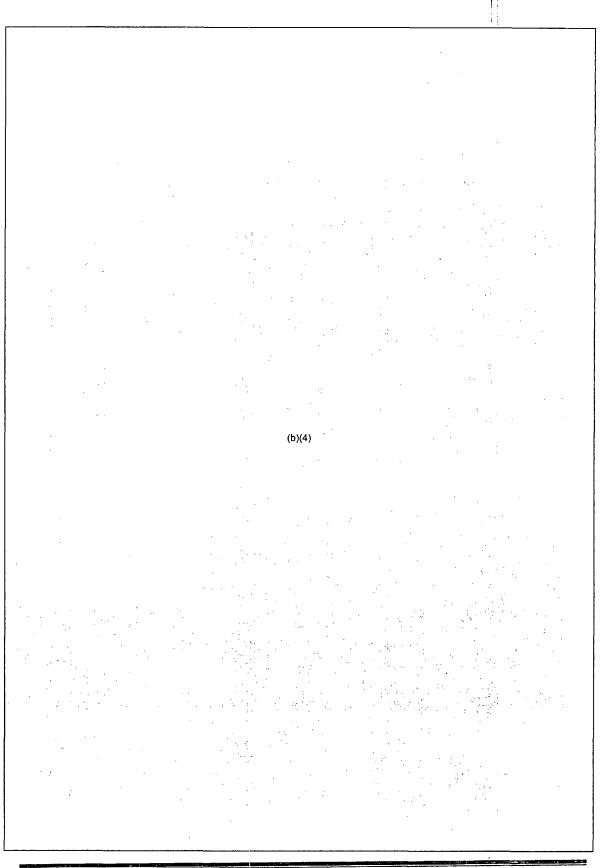


# Guidance for Return (Permanent Re-entry) of US Citizens to Areas around Fukushima Daiichi NPP

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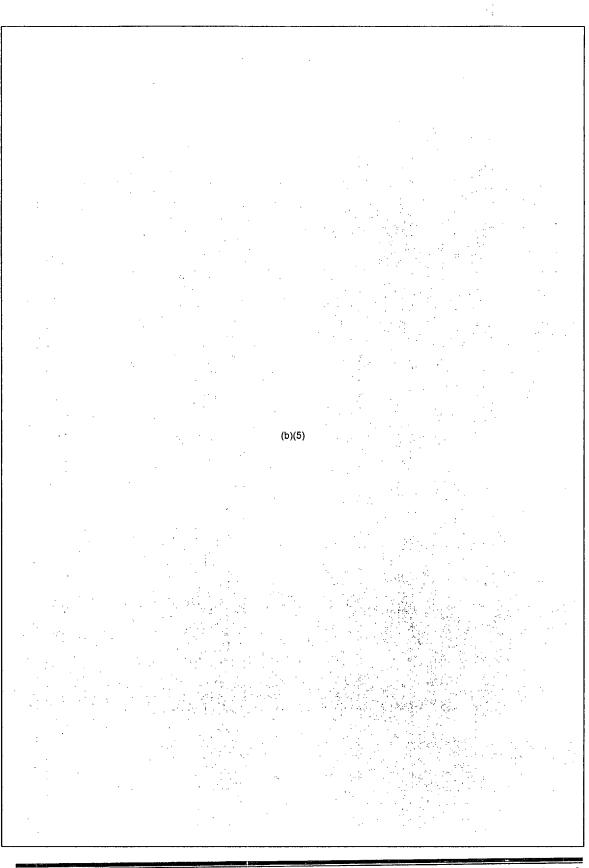
EY 454 of 942



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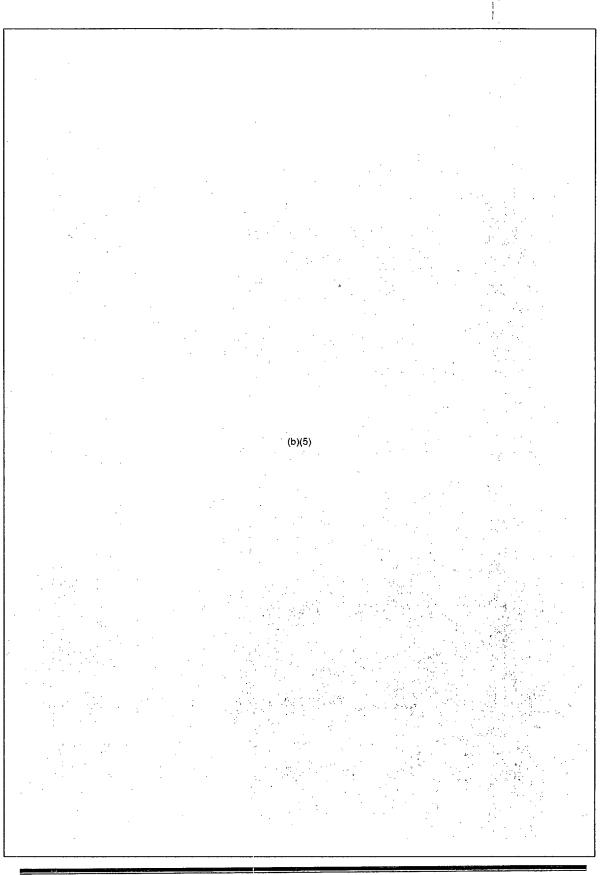
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EY 455 of 942



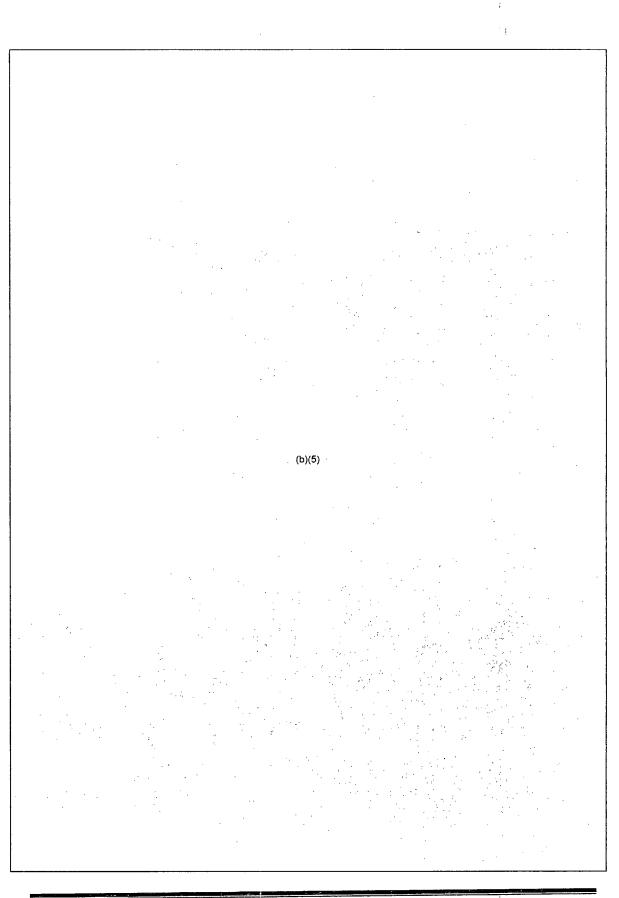
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EY 456 of 942



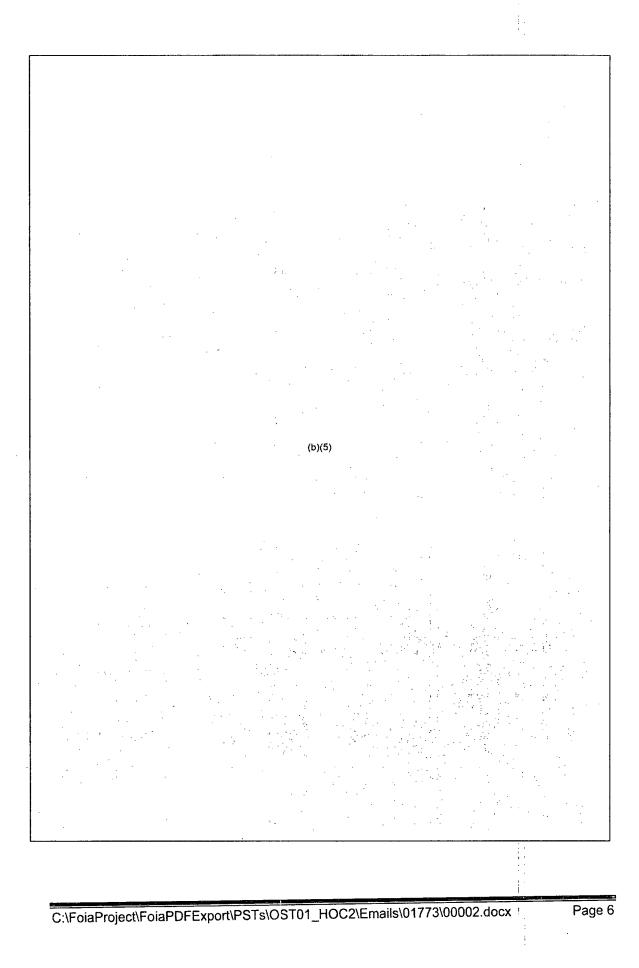
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EY 457 of 942



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EY 458 of 942



EY 459 of 942

1 RST08 Hoc From: Monday, April 11, 2011 4:31 AM Sent: To: RST01 Hoc Cc: RST06 Hoc Subject: RST Assessment Document, Rev.2 DRAFT 04-11-2011 0600 RST Assessment Document Rev 2.docx Attachments:

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, :

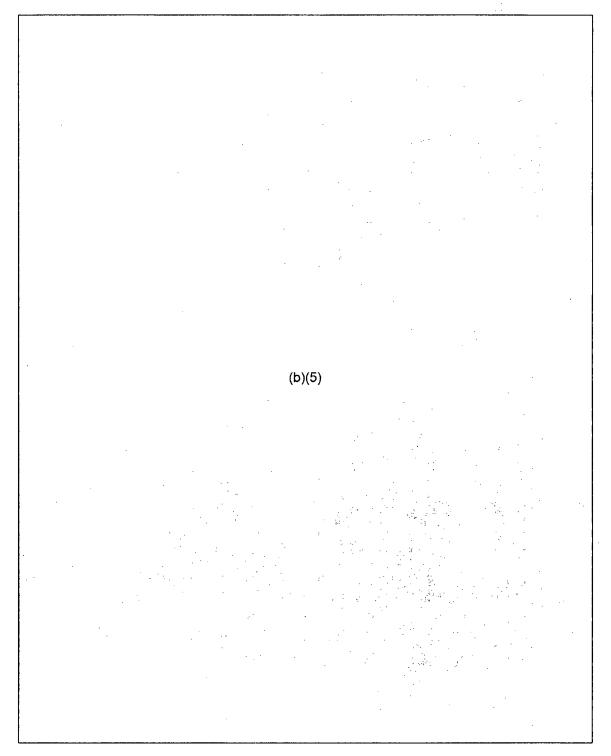
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Tim Kolb

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

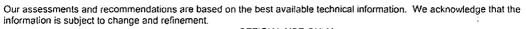
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### RST ASSESSMENT OF FUKUSHIMA DAHCHI UNITS (REV 2), Based on most recent available data and input from GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

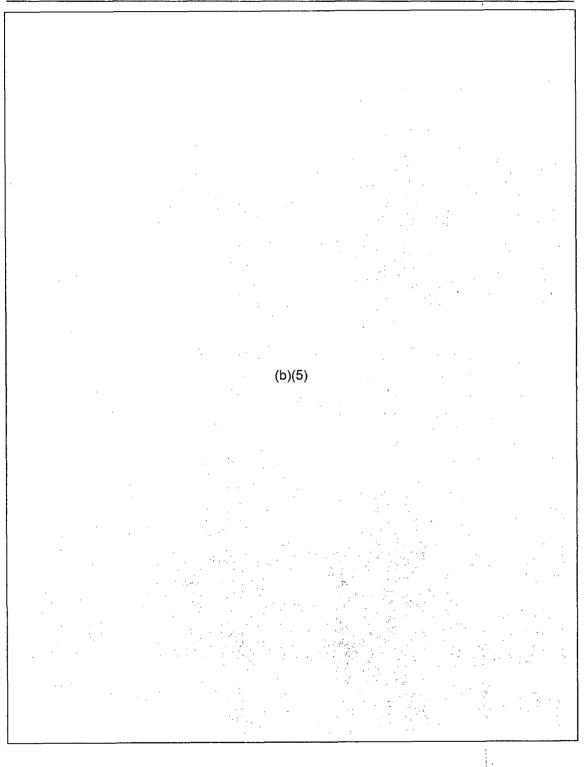


[Task Tracker 4254] Page 1 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 461 of 942

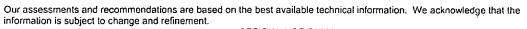


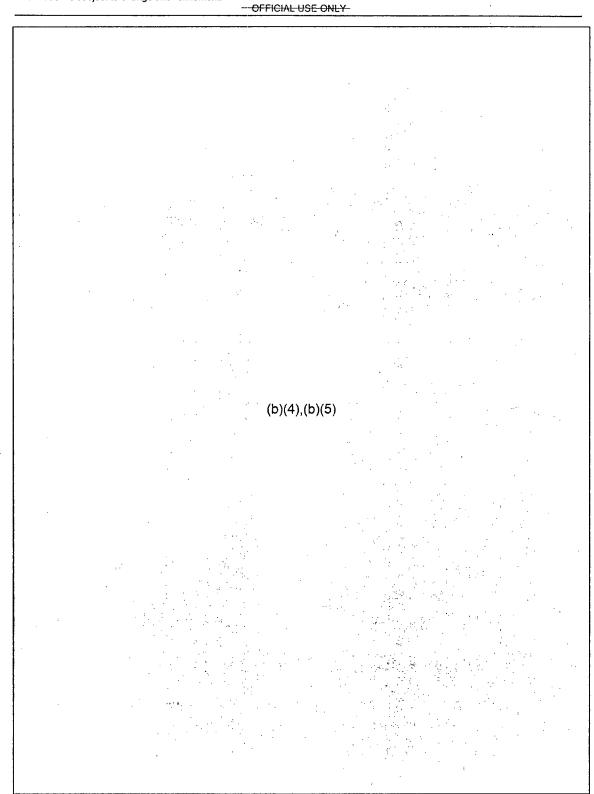
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[Task Tracker 4254] Page 2 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 462 of 942





[Task Tracker 4254] Page 3 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 463 of 942

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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.

<u>Minimum Debris Symmergence 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 Sprav 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.

[Task Tracker 4254] Page 4 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 464 of 942

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## 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:

Primary Cont	
	(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 Co	ontainment:
	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)

[Task Tracker 4254] Page 5 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 465 of 942

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)

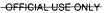
The following recommendations are based upon SAMG guidelines and have been modified based on the current knowledge of plant conditions.

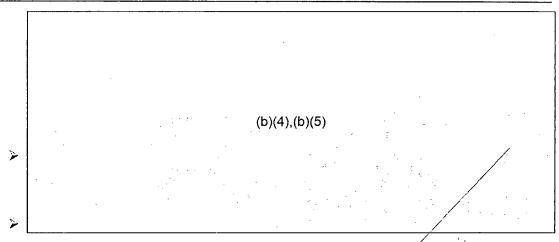
Inject into the RPV	with all avai	lable resources		
	•	(b)(4),(b)(5)		/
			i	
Vent containment	<u> </u>	(b)(4),(b)(5)	(See Additional	
Considerations A.1.	through A.5	below)	, '	
				ure limit.
c. d.		(b)(4),(b)(5)		
	Vent containment Considerations A.1. a. To maintain b. As necessary c.	Vent containment Considerations A.1. through A.5 a. To maintain containmen b. As necessary to maintair c.	Vent containment (b)(4),(b)(5) Considerations A.1. through A.5 below) a. To maintain containment pressure below the p b. As necessary to maintain RPV injection above c. (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 press b. As necessary to maintain RPV injection above MDRIR. c. (b)(4) (b)(5)

[Task Tracker 4254] Page 6 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 466 of 942

Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

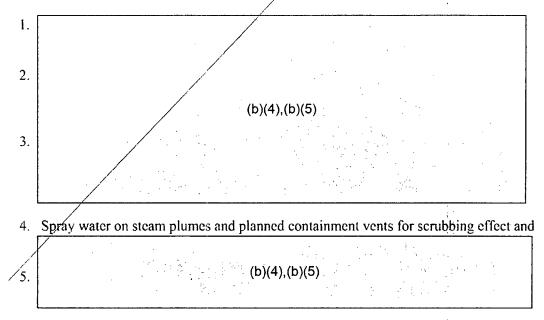




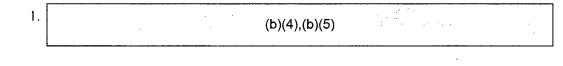
 Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The goal is to raise primary containment water level to at least the top of active fuel (TAF). (See Additional Considerations C.1. through C.4 below).

## **Additional Considerations**

A. The following considerations apply to containment venting:



## B. Additional Miscellaneous considerations



EY 467 of 942

[Task Tracker 4254] Page 7 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

(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 scismic capability of containment. C. Potential methods for monitoring containment level: (b)(4),(b)(5)HPCI(b)(4),(b) suction pressure and Drywell 1. instrument taps 2. Radiation monitoring instruments (b)(4),(b)(5) 3. 4. (b)(4),(b)(5) 5.

[Task Tracker 4254] Page 8 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

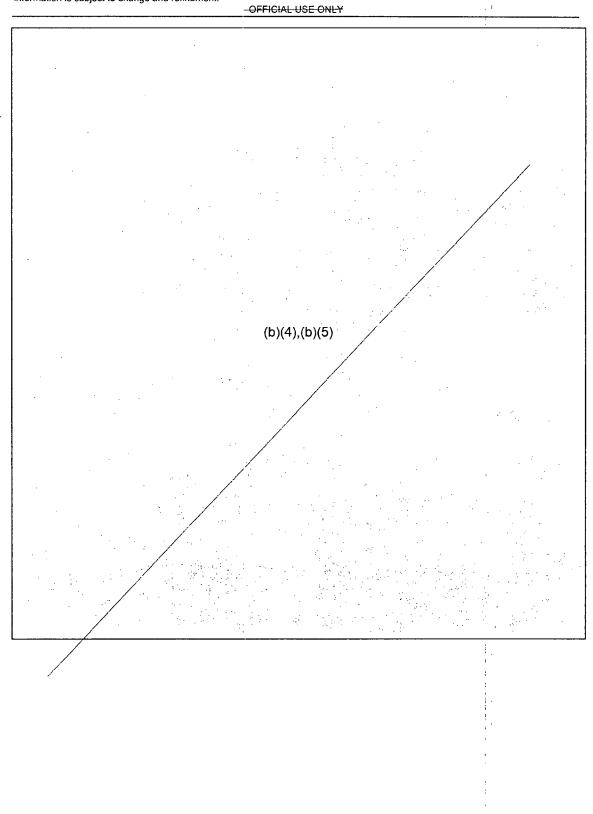
EY 468 of 942

Our assessments and recommendations are based on the best available technical information. We acknowledge that the

information is subject to change and refinement. -OFF	ICIAL USE ONLY
UNIT 1 - SPENT FUEL POOL STATUS (14	400 April 6 <sup>th</sup> )
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: Criticality status: Fuel Pool Level:	No data No data 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, MISA, TEPCO)
Other: On March 12, 2011 at 15:36	JT, a hydrogen explosion occurred during venting.
	(b)(4),(b)(5)
Jnit 1 Assessment:	
(b	)(4),(b)(5)
Unit 1 Recommendations:	
	(b)(4),(b)(5)
Unit 1 Additional Considerations:	
-	(b)(4),(b)(5)
[Task Tracker 4254]	Page 9 DRAFT - 0600 April 11, 201

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EY 469 of 942



 [Task Tracker 4254]
 Page 10
 DRAFT - 0600 April 11, 2011

 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 470 of 942

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EY 471 of 942

### 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 $\downarrow$ (NISA 4/8),
Com Continu	
Core Cooling	: Freshwater injection 30.8 gpm↔ (NISA 4/8)
	(b)(4),(b)(5)
Ponotor Drace	sure Vessel structural Integrity – Unknown
Reactor Fress	are vesser structural integrity – Onknown
Primary Cont	ainment:
Timary Cont	
	Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)
	Drywell pressure reading -0.2 psig↔ (NISA 4/8)
Secondary Co	ontainment:
	(b)(4),(b)(5)
	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)
	i

 [Task Tracker 4254]
 Page 11
 DRAFT - 0600 April 11, 2011

 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi
 Image: Comparison of Fukushima Daiichi

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#### 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 jcopardy 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.

11

EY 472 of 942

<ul> <li>Inject into the RPV with</li> <li>(b)(4),(b)(5)</li> </ul>	all available resources	(b)(4),(b)(5)
a. core spray (b)(4), b. feedwater system	(b)(5) n	,(b)(5)
c. other systems as d. (b)(4),(b)	they become available (5)	
<u>خۇ</u>	(b)(4),(b)(5)	

[Task Tracker 4254] Page 12 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

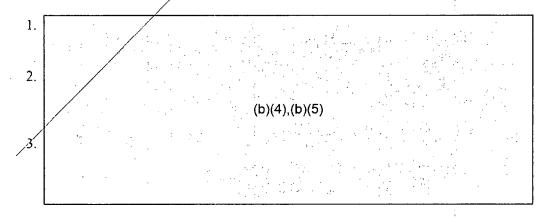
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(b)(	4),(b)(5)	•		
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- > Vent containment: (see Additional Considerations A.1. through A.5. below)
  - a. To maintain containment pressure below the primary containment pressure limit.
  - b. As necessary 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:



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

[Task Tracker 4254] Page 13 DRAFT - 0600 April 11, 2011 M:\RSTJapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 473 of 942

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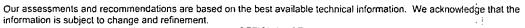
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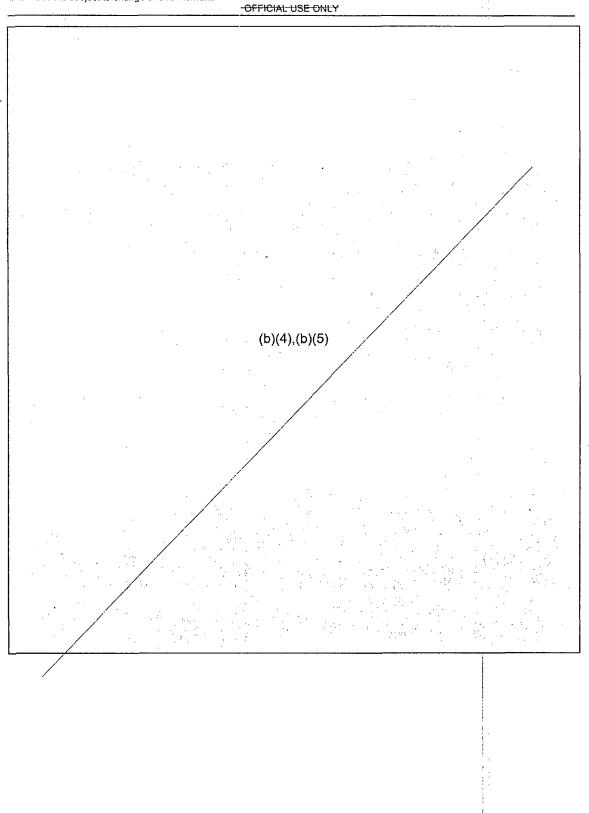
5.	(b)(4),(b)(5)	
3. Addi	tional Miscellaneous considerations	
2. E 3. In c. 4. V	Forate water if possible. Insure spent fuel pool level is maintained as full as possible. Injection of water via the CRD system is desired to provide cooling of ore and for cooling material on bottom of vessel. When flooding containment, consider the implications of water weig apability of containment.	
C. Poter	ntial methods for monitoring containment level. (b)(4),(b)(5) (b)(4),(b)(5) . (b)(4),(b)(5) . (b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pressure instrument taps	and Drywell
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UNIT 2 - SPENT FUEL POOL STATUS		i . : T
Amount of fuel:	587 bundles	
Last transfer from Reactor:	116 bundles (September 20-25, 20	10)
Decay Heat [megawatt thermal (MWth)]:	0.47 MWth; evaporation rate 5240 g	gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)	····
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data Full ((b)(6) 4/3)	
Water Injection Method and Source:	Fresh water injected to the spent fu injected 36 tons on 4/7/11	el pool. Last
Fuel Pool Water Temperature:	71°C (TEPCO 4/5)	; ;
Other: External AC power has reac before energizing.	hed the unit, checking the integrity of (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)	

[Task Tracker 4254] Page 15 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi





[Task Tracker 4254] Page 16 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 476 of 942

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#### 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 $\downarrow$ , ch B<sup>2</sup> -11.4 psig)  $\leftrightarrow$  (NISA 4/8); RPV temp: Btm Head 110.8°C $\leftrightarrow$ ; FW nozzle: S8.8°C $\leftrightarrow$  (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  $psig \leftrightarrow (NISA/4/8)$ , Torus pressure 10.3  $psig \leftrightarrow (NISA/4/8)$ 

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 Levelş: 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 pc	ower (NISA 4/3).			
		(b)(4),(b)(5)	· · · · · ·		
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#### 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 saft 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.

	RPV with all available r	tions. esources	(b)(4)	i,(b)(5)	
(b)(4),(b)(5) a. core sp		(b)(4),(			J
b. feedwa	(b)(4),(b)(5) ter system ystems as they become a (b)(4),(b)(5)				
>					
÷					
		(b)(4),(b)(5)			
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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)

[Task Tracker 4254] Page 19 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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Our assessments and recommendations are based on the best available technical information.	We acknowledge that the
information is subject to change and refinement.	Ĩ.
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### **Additional Considerations**

A.	The	e 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.	Ad	ditional Miscellaneous consideration
	1.	(b)(4),(b)(5)
	2. 3.	Ensure spent fuel pool level is maintained as full as possible. 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.	Pot	tential methods for monitoring containment level. (b)(4),(b)(5)
		(b)(4),(b)(5) a. (b)(4),(b)(5) instrument taps
		b. Radiation monitoring instruments (b)(4),(b)(5)
		c. d. (b)(4),(b)(5)

[Task Tracker 4254] Page 20 DRA M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi DRAFT - 0600 April 11, 2011

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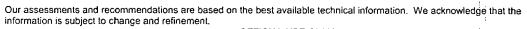
EY 480 of 942

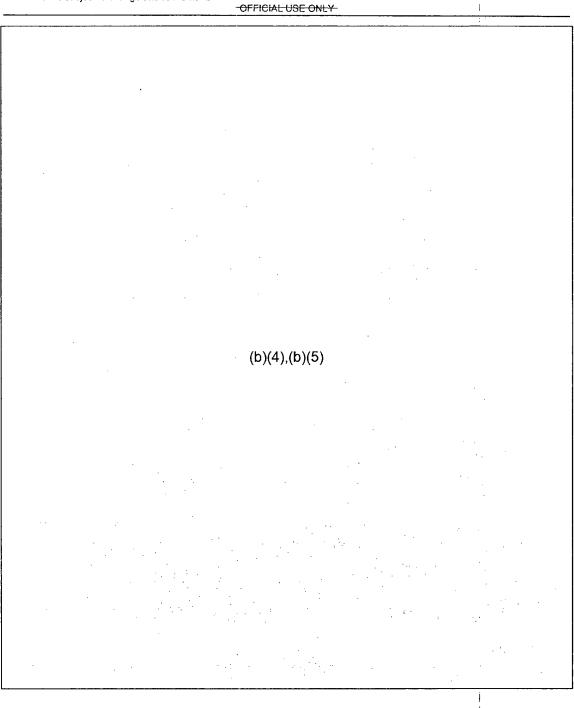
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Our assessments and recommendations are based on the best available technical information. We acknowledge that the

information is subject to change and refinement.	OFFICIAL USE-ONLY
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: Criticality status: Fuel Pool Level:	No data No data 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)

[Task Tracker 4254] Page 21 DRA M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi DRAFT - 0600 April 11, 2011 i





EY 482 of 942

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# 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)

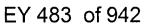
# ASSESSMENT:

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 ancovered. 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 water.
 (b)(4),(b)(5)
 As possible, put spent fuel cooling and cleanup in service.



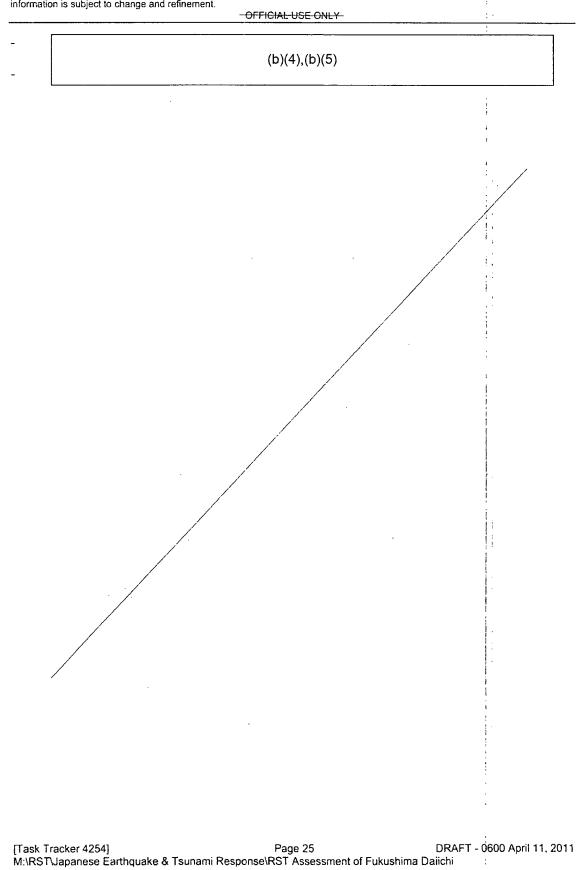
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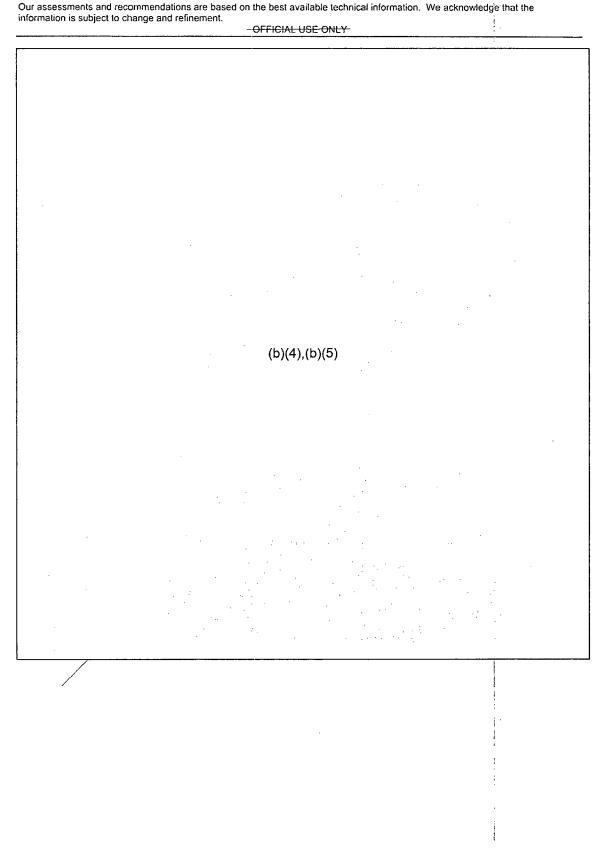
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UNIT 4 - SPENT FUEL POOL STATUS	
Amount of fuel:	1331 bundles
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (MWth):	1.86 MWth
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data 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 rea equipment before energizin	nched the unit, checking electrical integrity of ng.
Unit 4 Assessment:	
	(b)(4),(b)(5)
Unit 4 Recommendations:	(b)(4),(b)(5)
- · · · · · · · · · · · · · · · · · · ·	
Unit 4 Additional Considerations:	
[Task Tracker 4254] M:\RST\Japanese Earthquake & Tsunami Respons	Page 24 DRAFT - 0600 April 11, 2011 se\RST Assessment of Fukushima Daiichi

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EY 484 of 942



EY 485 of 942

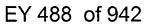


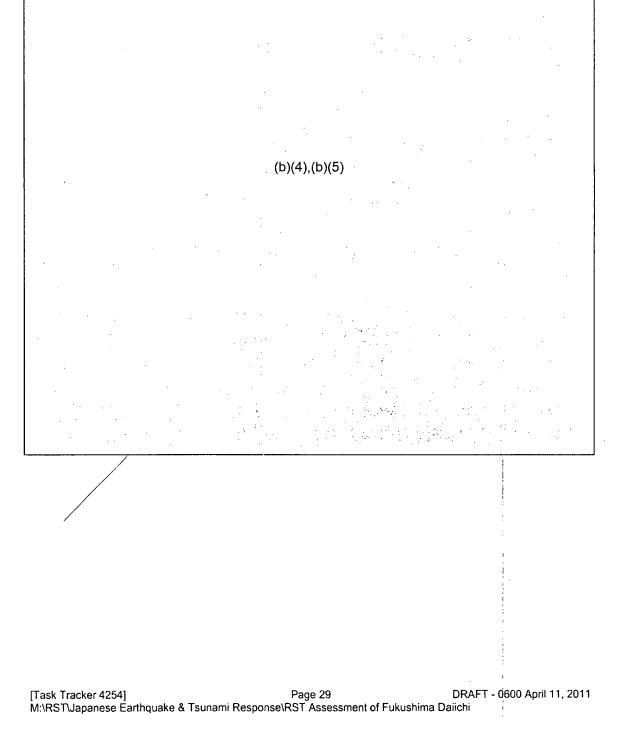
DRAFT - 0,600 April 11, 2011 [Task Tracker 4254] Page 26 DRA M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



-OFFICIAL USE-ONLY-**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  $\leftrightarrow$  (NISA 4/8); Temp: 45.5°C $\uparrow$  (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: 34.7oC1 (JAIF 4/8); Coøling 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

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UNIT 5 - SPENT FUEL POOL STATUS		
Amount of fuel:	946 bundles	
Last transfer from Reactor:	120 bundles (January 8-13, 2011)	7 1 8 1
Decay Heat (MW):	0.8 MW (b)(6)	f 
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)	
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data Full	
Water Injection Method and Source:	Fuel pool cooling	
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)	
Other: External AC power supplying Pool Cooling lost when pump complete on RHR pump used		
Unit 5 Assessment:	Jnit 5 Assessment:	
<ul> <li>Unit 5 is stable with cooling capacity</li> </ul>		
Unit 5 Recommendations:		2   ·     
-	(b)(4),(b)(5)	
Unit 5 Additional Considerations:		
	(b)(4),(b)(5)	



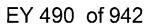


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Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

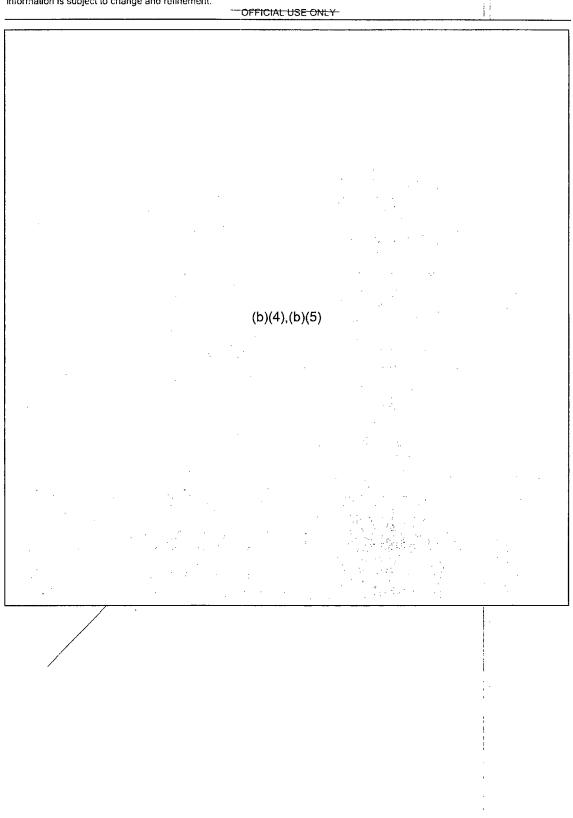
EY 489 of 942

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	nd recommendations are based on the best available technical information. We acknowledg ct to change and refinement. -OFFICIAL USE ONLY-	e that the
UNIT SIX CO	DRE	
ASSUMPTIO	NS: (based on input from multiple data source: JAIF, NISA, TEPC	O, & GEH)
Core Status:	(b)(4),(b)(5) (JAIF, NISA, TEPCO)	In vessel
	(b)(4),(b)(5)	
Core Cooling:	Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5) (b)(4),(b)(5)	
Primary Conta	inment: Functional (JAIF, NISA, TEPCO)	
Secondary Con	ntainment: Vent hole drilled in rooftop to avoid hydrogen build up (JAJF. NIS.	A, TEPCO)
Spent Fuel Po	ol: 876 bundles (b)(6) Temp: 30.5.0°C↑ (NISA 4/8): Cooling capabil (JAIF 4/1). Fuel pool cooling functioning.	ity recovered
Other:	(b)(4),(b)(5)	l
ASSESSMEN	NT:	i ; ; ; ;
Unit Six is rela	atively stable.	
RECOMME	NDATIONS:	
1. Monito	or	
ABBREVIA	TIONS:	
INPO – Institu JAIF – Japan NISA – Nucle	al Electric Hitachi ate of Nuclear Power Operations Atomic Industrial Forum ar and Industrial Safety Agency tyo Electric Power Company	
		• •



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nformation is subject to change and refinement.	DEFICIAL USE ONLY
UNIT 6 - SPENT FUEL POOL STATUS	
Amount of fuel:	876 bundles
_ast 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: Criticality status: Fuel Pool Level:	No data No data 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)
	ing the unit, Unit 6 diesel generators available. Fuel imp failed (JAIF, NISA, and TEPCO). Repairs sed for fuel pool cooling.
Unit 6 Assessment:	
- Unit 6 is stable with cooling capac	city recovered.
Unit 6 Recommendations:	
-	(b)(4),(b)(5)
Unit 6 Additional Considerations:	
-	(b)(4),(b)(5)
،	



[Task Tracker 4254] Page 32 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 492 of 942

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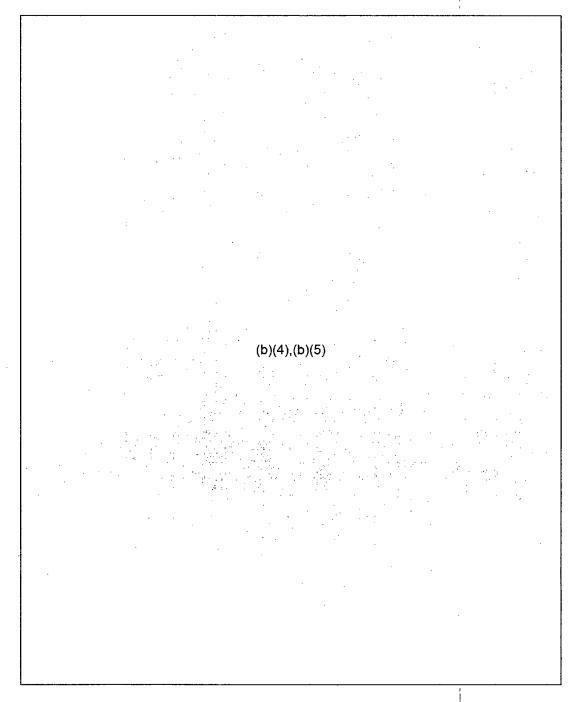
EY 493 of 942

COMMON - SPENT FUEL POOL STATUS	<u>}</u>	
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: Criticality status: Fuel Pool Level:	No data No data 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		
<ol> <li>EPRI recommendations March 18, 2</li> <li>SFP Criticality Potential, Kent Wood</li> <li>Spent Fuel Inventories Document</li> </ol>		
ABBREVIATIONS:		
GEH – General Electric Hitachi INPO – Institute of Nuclear Power Operatic JAIF – Japan Atomic Industrial Forum NISA – Nuclear and Industrial Safety Agen		
[Task Tracker 4254]	Page 33 DRAFT - 0600 April 11, 20	11

[Task Tracker 4254] Page 33 DRAFT - 06 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

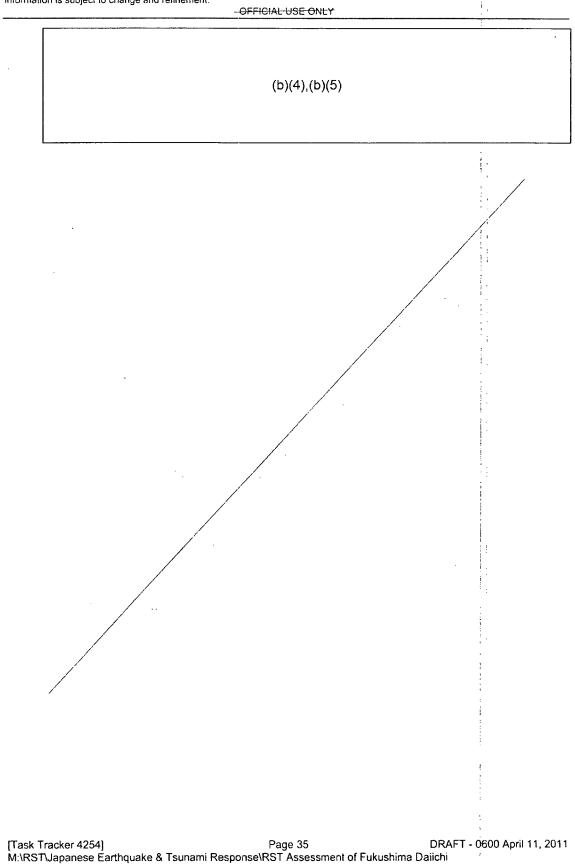
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TEPCO – Tokyo Electric Power Company
-ENCLOSURE-1

## 1. EPRI recommendations March 18, 2011



[Task Tracker 4254] Page 34 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

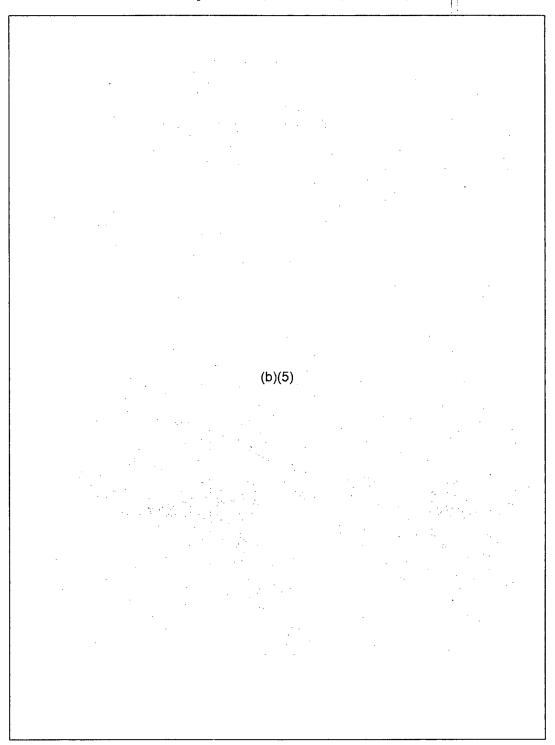
EY 494 of 942



EY 495 of 942

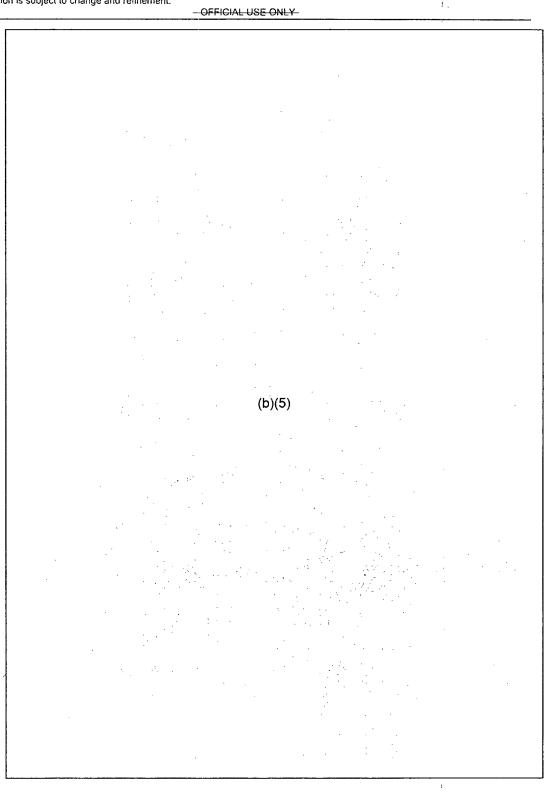
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### **ENCLSOURE 2**



SFP Criticality Potential, Kent Wood, March 24, 2011

[Task Tracker 4254] Page 36 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



[Task Tracker 4254] Page 37 DRAFT - 0,600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 497 of 942

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#### - Official Use Only 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

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.

# 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)(A)	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
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.

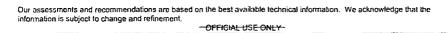
From:	RST01 Hoc
Sent:	Wednesday, April 13, 2011 9:40 PM
То:	Hiland, Patrick
Cc:	ET01 Hoc
Subject:	RST Assessment Rev 2
Attachments:	FW: NR Comments on RST Rev 2; DRAFT 04-12-2011 1200 RST Assessment Document Rev 2GEH_INPO_DOE.docx

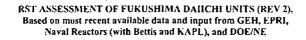
Mr. Hiland,

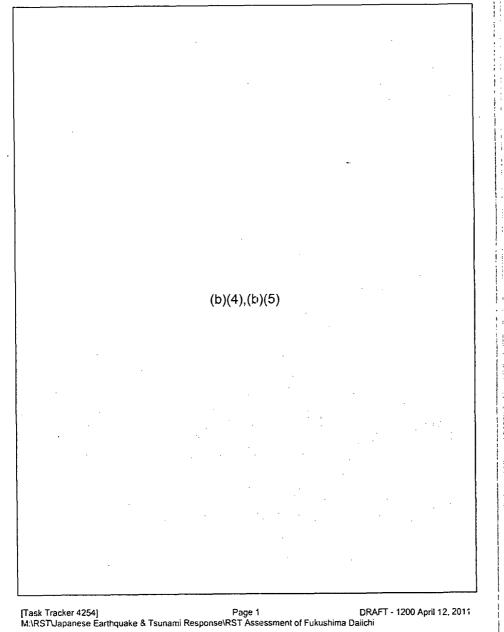
Attached is the RST Assessment Rev 2 which has GEH, INPO, and DOE comments. In addition, we included the email from NR which has their comments which have not been fully incorporated as of yet.

Regards, RST Team

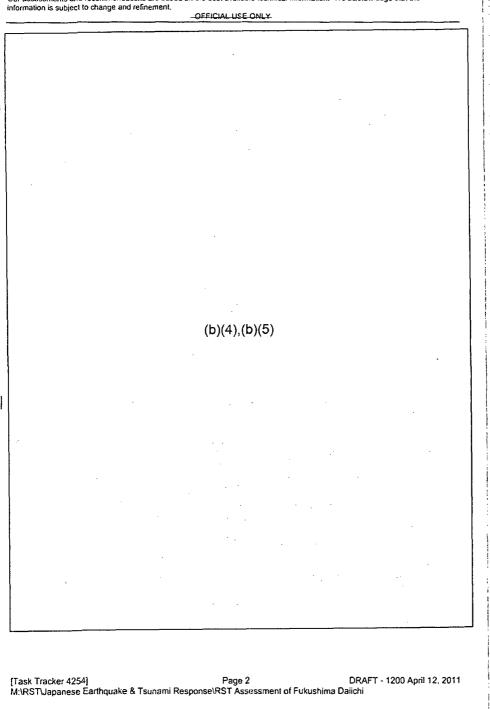
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EY 500 of 942



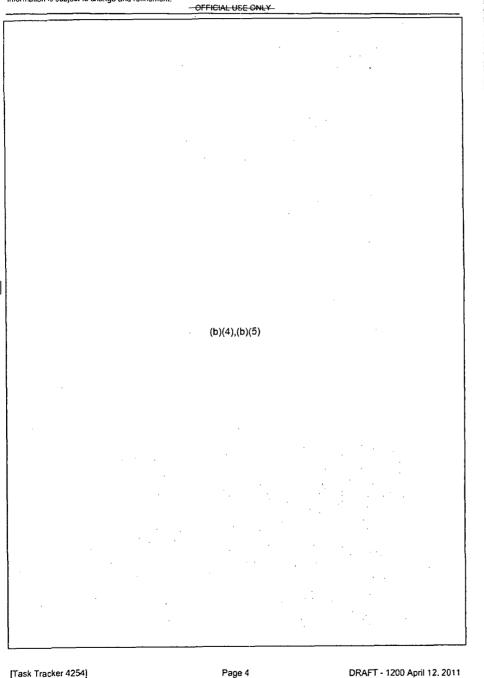
EY 501 of 942

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)
[Task Tracker 4254] Page 3 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 502 of 942

11



[Task Tracker 4254] Page 4 DRA M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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

Definitions

<u>Minimum Debris Retention Injection Rate (MDRIR)</u> is the lowest RPV injection rate abwhich 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 prinder containment water level at which it is expected that ex-vessel core debris on the dryweil floor will be adequately submerged. It is utilized to preserve primary containment integrity following RPV breach by core debris.

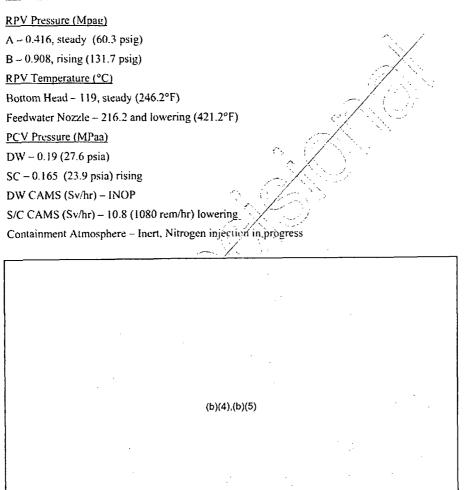
<u>Minimum Drywell Spray Flow (MDSF)</u> is the lovest spray flow that assures uniform circumferential spray distribution within the drywell. Flow rates less than this will not perform the spray function but only a flooding function/The MDSF is typically in thousands of gallons per minute.

[Task Tracker 4254] Page 5 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

### UNIT ONE CORE

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

Control Parameter Assessment: (As of 0700, 4/12/11)



[Task Tracker 4254] Page 6 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dalichi

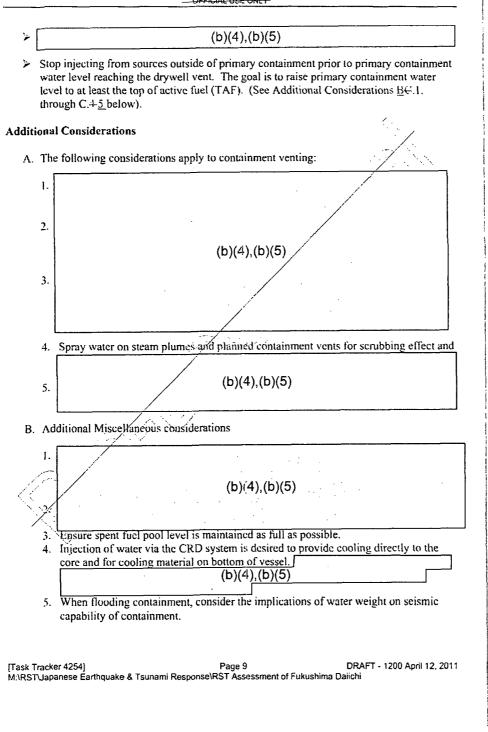
	and recommendations are based on the best available technical information. We acknowledge that the ject to change and refinement. -OFFICIAL USE ONLY	
Core Status:	(b)(4),(b)(5)	
	The volume of sea water	
	injected to cool the core has left enough salt to fill the lower plenum to the cor plate. (GEH, INPO, Bettis, KAPL).	e
fore Cooling	g: Recirculation pump seals have likely failed. (GEH); Injection flow fate above MDRIR could not be maintained through core spray. Assume sputdown cool	
	system is not available.	2
RPV -		
Structural Inte	tegrity: Unknown	
C		
Primary Cont	Damage suspected, slow leakage,	
	(b)(4),(b)(5)	
Secondary Co	ontainment: Severely damaged (hydrogen explosion)	
Rad levels:	Outside plant: 11 mR/br 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: JDT 3/24/2011. Lighting in Main Control Room is operating in U-1. Power been restored to the Main Control Room Panels (3/29/11 TEPCO).	
<i>,</i>		
	Reactor water is in the Turbine Building basement (NISA).	L
N. A.		
	(b)(4),(b)(5)	
ASSESSME		
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[Task Tracker 4254] Page 7 DRAFT - 1200 April 12, 2011 M:RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dalichi

Dur assessments and recomm nformation is subject to change	e and refinement.	est available technical in ICIAL USE ONLY	formation. We acknowledge that the	
water flow, if not blocl There is likely no wate	ked, should be filling r level inside the core icult to determine hov	the annulus region shroud. Natural c w much cooling is	past the fuel. GEH believes tha of the vessel to 2/3 core height circulation believed impeded by getting to the fuel. Vessel actual conditions.	
(b)(5) building roof.	shov	vs entire fuel floor	covered by grey-brown debris o	of
The primary containme	ent is potentially dam	aged (b)(4),(	b)(5)	
RECOMMENDATIC	ONS: (for considerati	on to stabilize Uni		
The following prioritie	s are consistent with	SAMG guidelines.		
		,		
	(b)	)(4),(b)(5) 📝	,	
		1		
➢ Inject into the F	RPV with all available			
➢ Inject into the F	RPV with all available	57csources (b)(4),(b)(5)		/
Vent containme	ent	(b)(4),(b)(5) (b)(4),(b)(5)	(See Additional	 _/ 
<ul> <li>Vent containme</li> <li>Considerations</li> </ul>	ent ( A) (, through A.5 belo	(b)(4),(b)(5) (b)(4),(b)(5) (bw)		
<ul> <li>Vent containme</li> <li>Considerations</li> <li>a. To main</li> </ul>	ent ( A) (, through A.5 belo	(b)(4),(b)(5) (b)(4),(b)(5) (b)(4),(b)(5) (b)(5) (b)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(	imary containment pressure lim	/ 
<ul> <li>Vent containme</li> <li>Considerations</li> <li>a. To main</li> </ul>	ent AX, through A.5 belo rain, containment pre-	(b)(4),(b)(5) (b)(4),(b)(5) (b)(4),(b)(5) (b)(5) (b)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(	imary containment pressure lim	
<ul> <li>Vent containme</li> <li>Considerations</li> <li>a. To main</li> </ul>	ent AX, through A.5 belo rain, containment pre-	(b)(4),(b)(5) (b)(4),(b)(5) (b)(4),(b)(5) (b)(5) (b)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(	imary containment pressure lim	
<ul> <li>Vent containme</li> <li>Considerations</li> <li>a. To main</li> </ul>	ent AX, through A.5 belo rain, containment pre-	(b)(4),(b)(5) (b)(4),(b)(5) (b)(5) (b)(5) (b)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(	imary containment pressure lim	
<ul> <li>Vent containme</li> <li>Considerations</li> <li>a. To main</li> </ul>	ent AX, through A.5 belo rain, containment pre-	(b)(4),(b)(5) (b)(4),(b)(5) (b)(4),(b)(5) (b)(5) (b)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(	imary containment pressure lim	
<ul> <li>Vent containme</li> <li>Considerations</li> <li>a. To main</li> </ul>	ent AX, through A.5 belo rain, containment pre-	(b)(4),(b)(5) (b)(4),(b)(5) (b)(5) (b)(5) (b)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(5) (c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(c)(	imary containment pressure lim	

EY 507 of 942

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C. Potential methods for monitoring containment level:

sk Tracker 4254) Page 10 DRAFT - 1200 April 12, 2011	1.	(b)(4),(b)(5) HPC(b)	(4),(b)(5) ection pressure and Drywell
3. 4. 5.	2.	Radiation monitoring instruments	(b)(4).(b)(5)
	3. 4.	(b)(4	)_(b)(5)
isk Tracker 4254) Page 11 DRAFT - 1200 April 12. 2011 RST Japanese Earthquake & Tsunami ResponseiRST Assessment of Fukushima Daiichi	5.		
sk Tracker 4254) Page 10 DRAFT - 1200 April 12.2011 RST.Japanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi			
risk Tracker 4254) Page 10 DRAFT - 1200 April 12. 2011 RST Vapanese Earthquake & Tsunami Response VRST Assessment of Fukushima Daiichi			
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EY 509 of 942

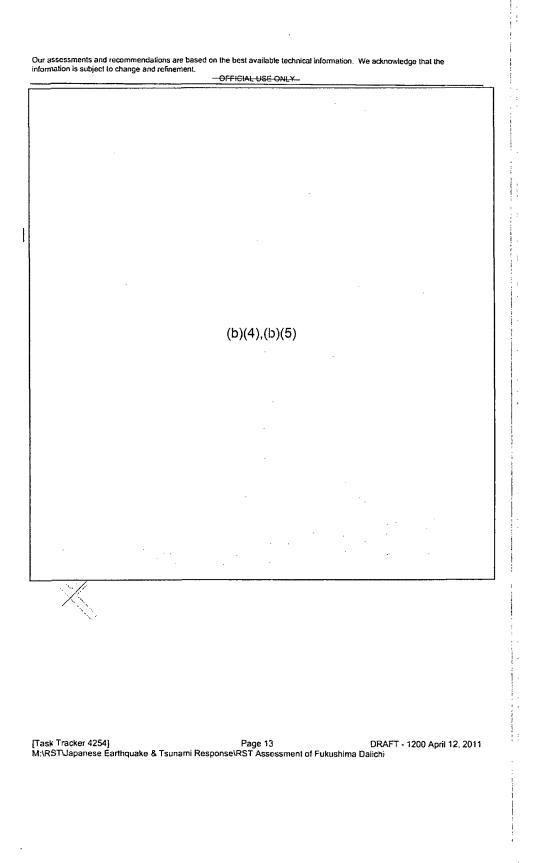
# UNIT 1 - SPENT FUEL POOL STATUS (1400 April 6th)

Amount of fuel	:	292 bundles
Last transfer fr	om Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [rr	negawatt thermal (MWth)]:	0.07 MWth((b)(6))evaporation rate 780 gallons per day
Fuel Pool Stru	ctural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Criticality statu Fuel Pool Leve	IS:	No data No data No data
Water Injectior	n Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck any
Fuel Pool Wate	er Temperature:	18°C (3/31 0815)
Power Status:		Electric power available; equipment testing in progress (JAJF, NISA, TEPCO)
Other:	On March 12, 2011 at 15:36	JT, a hydrogen explosion occurred during venting.
		(b)(4),(b)(5)
Unit 1 Assessr	ment:	
	(b)(	(4),(b)(5)
Unit 1 Recomm	nendations:	
		(b)(4),(b)(5)
Unit 1 Addition	al Considerations:	
-		(b)(4),(b)(5)
[Task Tracker 425 M:\RSTJapanese		Page 11 DRAFT - 1200 April 12, 2011 RST Assessment of Fukushima Dailchi

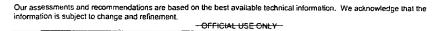
EY 510 of 942

[Task Tracker 4254] Page 12 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 511 of 942



EY 512 of 942



### 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) <u>RPV Temperature (°C)</u> Bottom Head – 208.1, steady (406°F) Feedwater Nozzle – 165.8 and lowering (330°F)

PCV Pressure (MPaa)

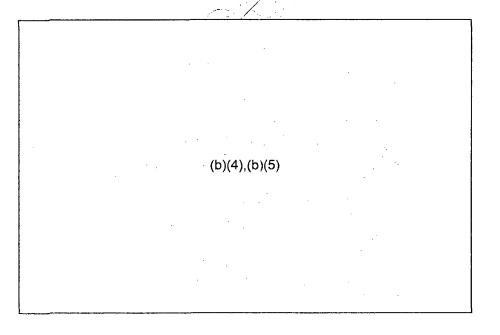
DW - 0.09 (13.1 psia)

SC – unknown

DW CAMS (Sv/hr) - 28.1 (2810 rem/hr)

S/C CAMS (Sv/hr) - .68 (68 rem/hr)

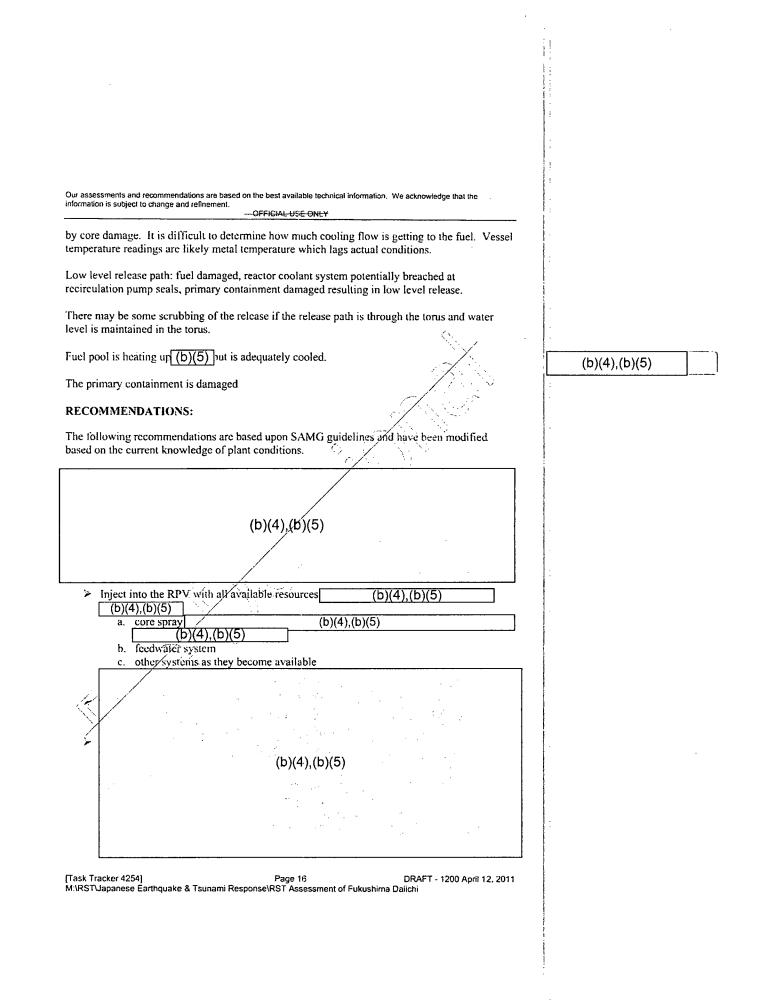
Containment Atmosphere - Unknown, nitrogen injection scheduled to begin 4/20/11



[Task Tracker 4254] Page 14 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

	OFFICIAL USE ONLY
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 Coolin	g: Recirculation pump seals have likely failed. (Industry)
Reactor Pres	sure Vessel structural Integrity – Unknown
Primary Cor	itainment:
	Damage and leakage suspected (JAIF, NISA, TEPCO) (INPO)
Secondary C	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)
ASSESSM	ENT:
	el muy have slumped with the majority located on the core plate and fuel in the
	FOT the core is likely encased in salt. However, the amount of salt build-up appears
	(b)(4),(b)(5)
continued sa	Core flow capability is in jeopardy due to
low past the	ter through the low pressure core injection line is cooling the vessel, but with limited e fuel. Water flow, if not blocked, should be filling the annulus region of the vessel
	eight. While core flow capability may be affected due to continued salt build up, evel indication is suspect due to environment. Natural circulation believed impeded
	4254) Page 15 DRAFT - 1200 April 12, 201
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EY 514 of 942



EY 515 of 942

information is subject to change and refinement.

Our assessments and recommendations are based on the best available technical information. We acknowledge that the OFFICIAL USE ONLY ۶ (b)(4),(b)(5) Vent containment: (see Additional Considerations A.1. through A.5. below) ۶ a. To maintain containment pressure below the primary containment pressure limit. b. As necessary to maintain RPV injection above MDRIR. To flood primary containment. c. d. (b)(4),(b)(5) Stop injecting from sources outside of primary containment prior to primary containment ۶ 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 C4B.4. through C.4-5 below) Ć **Additional Considerations** A. The following considerations apply to containment venting: 1. 2. (b)(4),(b)(5)3 Spray water on steam plumes and planned containment vents for scrubbing effect. 5. (b)(4),(b)(5) B. Additional Miscellancous considerations 1. Borate water if possible.

DRAFT - 1200 April 12, 2011 [Task Tracker 4254] Page 17 M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

- 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.

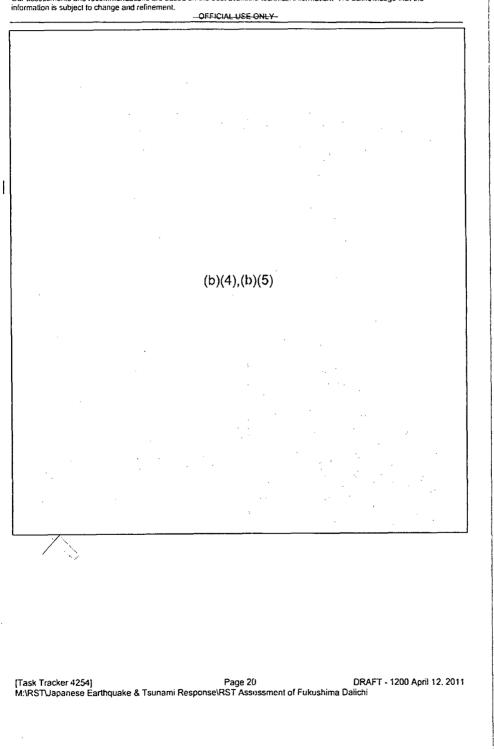
C. Potentia	$\frac{1 \text{ methods for monitori}}{(A)}$	ing containment level.	(b)(4),(b)(5)
(u) — —			1 · · · · ·
<del>a</del> . <u> </u>	(b)(4),(b)(5)	HPC (b)(4),(b)(5)	ection pressure and Drywell
instr	ument taps <u>.</u> ation monitoring instr		(b)(4)(b)(E)
<u>+-3</u>	ation monitoring fisu		(b)(4),(b)(5)
4.4			
		(b)(4),(b)(5)	
e- <u>5</u>			
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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)
1	Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data Full (b)(6) #/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 reac before energizing.	hed the unit: checking the integrity of equipment (b)(4),(b)(5)
	Unit 2 Assessment:	a fa the second s
	(b)(4	ч), (b)(5)
	Unit 2 Recommendations:	
	-	
		(b)(4),(b)(5)
	Unit 2 Additional Considerations:	
	-	(b)(4),(b)(5)
	[Task Tracker 4254] M:\RSTUapanese Earthquake & Tsunami Response	Page 19 DRAFT - 1200 April 12, 2011 \RST Assessment of Fukushima Daiichi

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### UNIT THREE CORE

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

Control Parameter Assessment: (As of 0700, 4/12/11)

 <u>RPV Pressure (MPag)</u>

 A - (-.019), steady (-2.8 psig)

 B - (-0.079), steady (-11.5 psig)

 <u>RPV Temperature (°C)</u>

 Bottom Head - 105, steady (222°F)

 Fcedwater Nozzle - 105.4 and lowering (221.7°F)

 <u>PCV Pressure (MPaa)</u>

 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)

[Task Tracker 4254] Page 21 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

Core Status:

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

Core Cooling: Recirculation pump seals have likely failed.

On offsite AC power (NISA 4/3

Reactor Pressure Vessel structural Integrity - Unknown

Primary Containment

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

0

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

Secondary Containment

514 bundles

Damaged (JAIF, NISA, TEPCO). Severe damage from H2 explosion.

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

Spent Fuel Pool

Other:

L

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 vater 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.

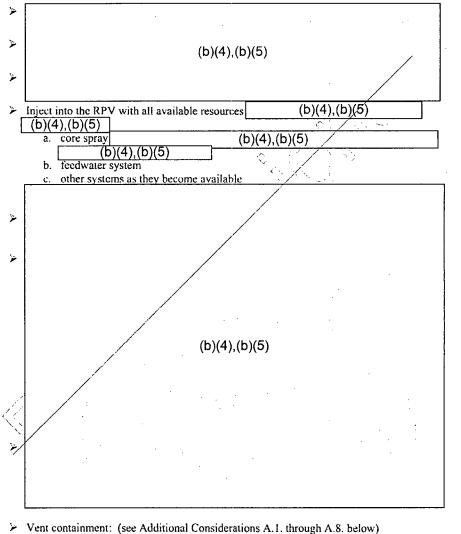
[Task Tracker 4254]	Page 22	DRAFT -	1200 April	12.201	11
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Fuel pool is heating up but is adequately cooled, and fuel may have been ejected from the pool (based on information from TEPCO of neutron sources found up to 1 mile from the units, and very 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). 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.

[Task Tracker 4254] Page 23 DRAFT - 1200 April 12, 2011 M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

### **RECOMMENDATIONS:**

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



- a. To maintain containment pressure below the primary containment pressure limit.
  - b. As necessary to maintain RPV injection above MDRIR.

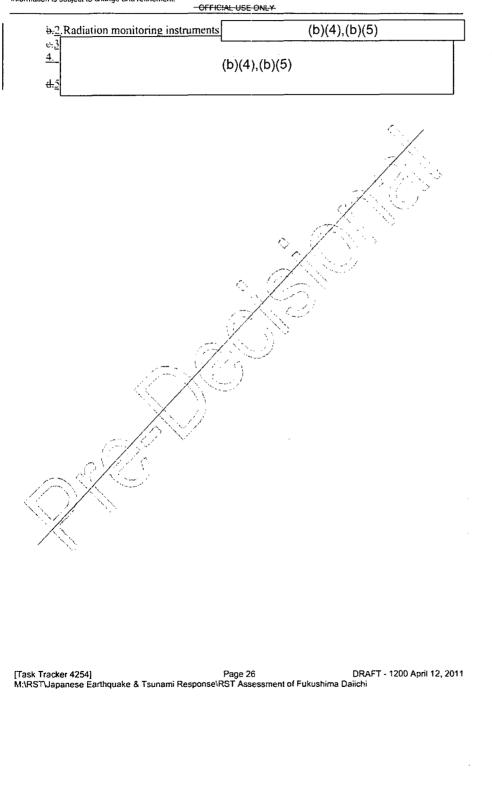
[Task Tracker 4254] Page 24 DRAFT - 1200 April 12, 2011 M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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-4B.4. through C.35. 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 Miscellancous consideration 1. (b)(4)(b)(5)Ensure spent fuel pool level is maintained as full as possible. 20 3. Rejection 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. (b)(4),(b)(5) Potential methods for monitoring containment level. (b)(4),(b)(5)(b)(4),(b)(5)(b)(4),(b)(5) ction pressure and Drywell <del>8.</del>] HPC instrument taps [Task Tracker 4254] Page 25 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailchi

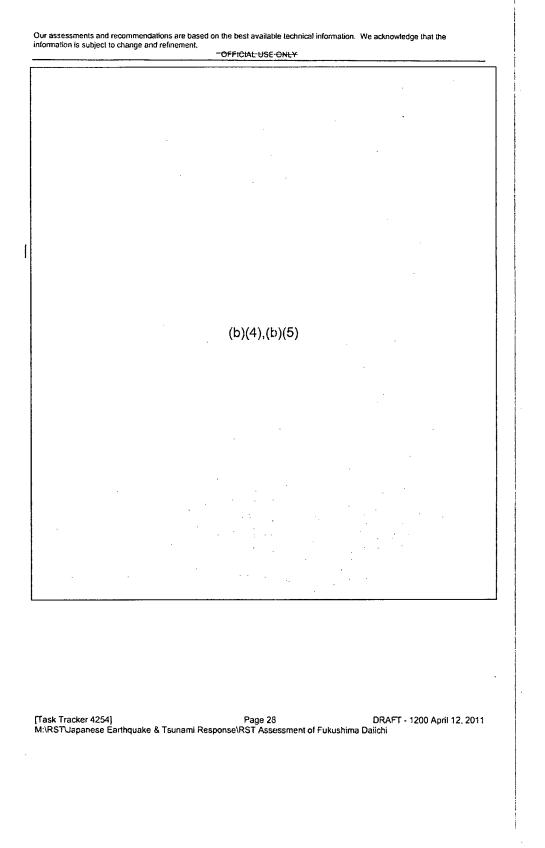
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EY 524 of 942



information is subject to change and refinement.	he best available technical information. We acknowledge that the
UNIT 3 - SPENT FUEL POOL STATUS	
Amount of fuel:	514 bundles
Last transfer from Reactor:	148 bundles (June 23 to 28, <del>2011</del> 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: Criticality status: Fuel Pool Level:	No data No data Full (b)(6) <del>//3)</del>
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:	a statistica de la companya de la co
	(b)(4),(b)(5)
Unit 3 Recommendations:	- ***** 
-	(b)(4).(b)(5)
= /	· · ·
Unit 3 Additional Considerations:	
-	(b)(4),(b)(5)
[Task Tracker 4254] M:\RST\Japanese Earthquake & Tsunami Respor	Page 27 DRAFT - 1200 April 12. 2011 Ise\RST Assessment of Fukushima Daiichi



EY 527 of 942

### 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)

Severely damaged, hydrogen explosion. (JAIF, NISA. TEPCO)

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

Secondary Containment:

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 hent in the fuel in the fool, 37 is likely that in the days immediately following the accident, the fuel was partially accorded. The lack of cooling resulted in zire water reaction and a release of hydrogen. The fixdragen exploded and damaged secondary communent. The zire water reaction 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 write, and very high doze rate material that had to be buildozed over between Units 3 and 4. To k also possible the material could have come from Unit 3).

## RECOMMENDATIONS:

Haintuin coverage of spent fuel pool with fresh water.-Boron used as necessary to computeritieality-with consideration of pH and boron solubility-limitations Approache, put spent fuel coeffing and cleanup in service.

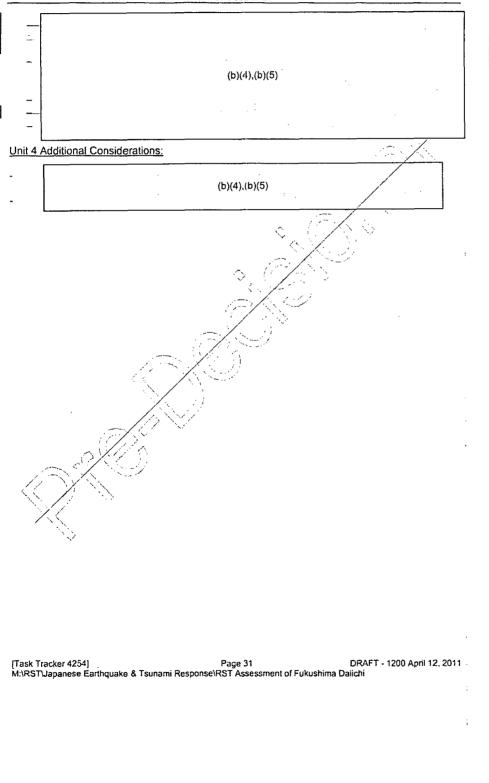
[Task Tracker 4254] Page 29 DR/ M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

DRAFT - 1200 April 12, 2011

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: Criticality status: Fuel Pool Level:	No data No data 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 reac	hed the unit, checking electrical integrity of
equipment before energizing	ゆ (人) - 水心 - 人)
equipment before energizing	
Unit 4 Assessment:	
Unit 4 Assessment:	p)(4),(b)(5)
Unit 4 Assessment:	
Unit 4 Assessment:	

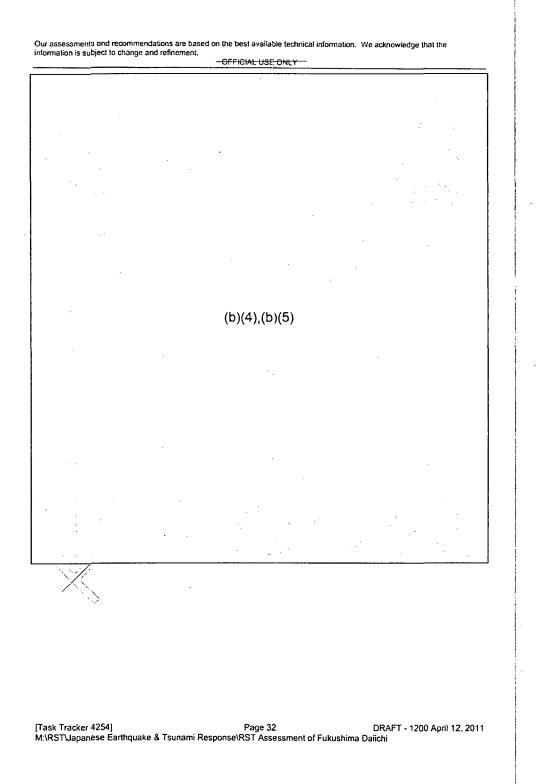
Unit 4 Recommendations:

[Task Tracker 4254] Page 30 DRAFT - 1200 April 12, 2011 M:RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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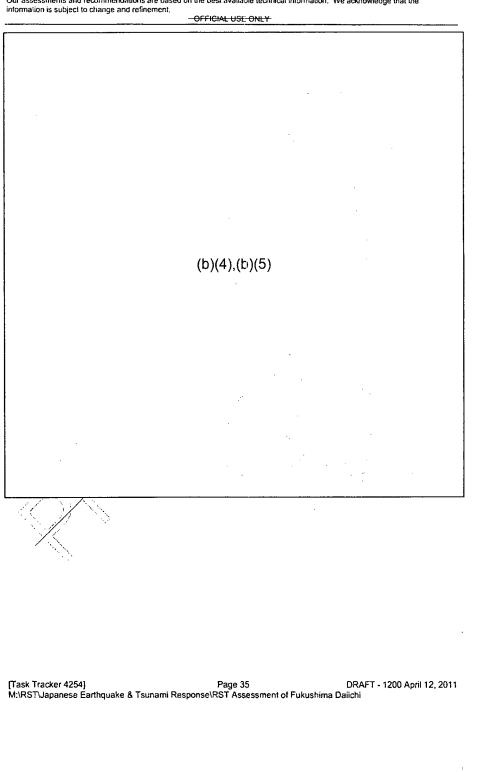
EY 531 of 942

	nd recommendations are based on the best available technical information. We acknowledge that the ct to change and refinement.
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UNIT FIVE C	
ASSUMPTIO	<b>NS:</b> (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)
Primary Conta	inment: Functional (JAIF, NISA, TEPCO)
Secondary Cor Vent h	ntainment: ole drilled in rooftop to avoid hydrogen build up (JAFF XISA, TEPCO)
Spent Fuel Poo 946 bu	ol: ndles (JAIF); Temp: 34.70C1 (JAIF 4/8); Cooling capability recovered (JAIF 4/1)
Other: On offs diesel g TEPCC	
	(b)(4),(b)(5)
ASSESSMEN	π.
Unit five is rel	atively stable.
Unit five is rel RECOMMEN	
RECOMMEN	
RECOMMEN	NDATIONS:
RECOMMEN Repairs compl	NDATIONS:
RECOMMEN Repairs compl Monitor	NDATIONS: Icte on RilR pump used for fuel pool cooling.
RECOMMEN Repairs compl Monitor	NDATIONS: lete on RHR pump used for fuel pool cooling.
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EY 532 of 942

Our assessments and recommendations are based on the best available technical information.	We acknowledge that the
information is subject to change and refinement.	0
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	UNIT 5 - SPE	NT FUEL POOL STATUS			
	Amount of fue	4:	946 bundles		
	Last transfer f	rom Reactor:	120 bundles (January 8-13, 2011)		
I	Decay Heat (I	MW):	0.8 MW (b)(6)		
	Fuel Pool Stru	uctural Support Integrity:	Not damaged (JAIF 4/4)		
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:		us:	No data No data Full		
	Water Injectio	n Method and Source:	Fuel pool cooling		
	Fuel Pool Wa	ter 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 Assess	ment:			
	– Unit 5	is stable with cooling capacity	recovered.		
	Unit 5 Recommendations:				
	- (b)(4),(b)(5)				
	Unit 5 Additional Considerations:				
	- - (b)(4),(b)(5)				
			•		
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EY 534 of 942

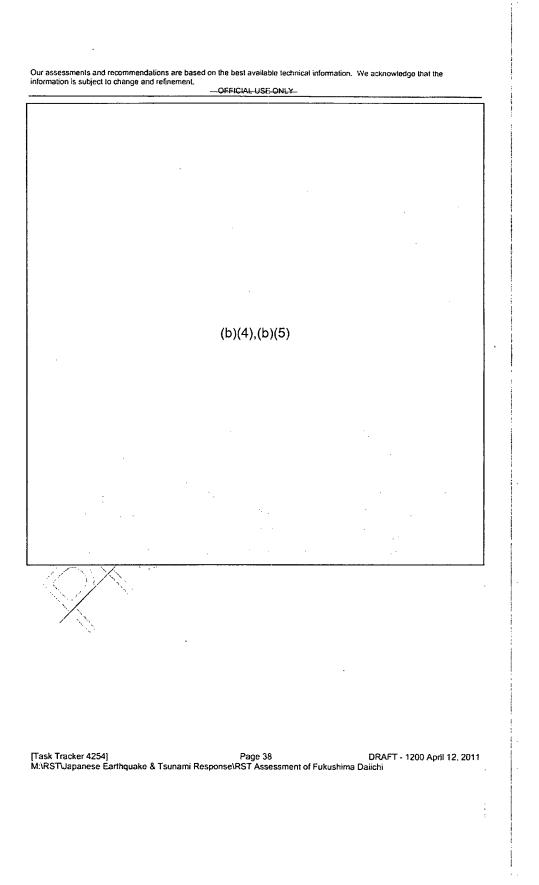
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UNIT SIX C	ORE
ASSUMPTI	ONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)
Core Status:	(b)(4),(b)(5) In vessel (JAIF, NISA, TEPCO)
	RPV: pressure .7 psig $\leftrightarrow$ (NISA 4/8); Temp: 22.7°C $\leftrightarrow$ (NISA 4/8);
Core Cooling	: Functional (JAIF, NISA, TEPCO) (b)(4),(b)(5) (b)(4),(b)(5)
Primary Cont	ainment: Functional (JAIF, NISA, TEPCO)
Secondary Co	ontainment: Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)
Spent Fuel Po	bol: 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)
ASSESSME Unit Six is re	NT:
	INDATIONS
I. Moni	SKS)
INPO – Insti JAIF – Japan NISA – Nucl	ral Electric Hitachi tute of Nuclear Power Operations Atomic Industrial Forum ear and Industrial Safety Agency kyo Electric Power Company

# UNIT 6 - SPENT FUEL POOL STATUS

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	Amount of fuel:		876 bundles
	Last transfer from R	leactor:	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 Integ Criticality status: Fuel Pool Level;	grity:	No data No data Full
	Water Injection Mether	hod and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
	Fuel Pool Water Ter	mperature:	28.5°C (TECPO 4/5)
Other: External AC power supplying the unit, Unit 6 dieset generators available. Fuel Pool Cooling lost when pump failed (JAIF, NISA, and TEPCO). Repairs complete on RHR pump used for fuel pool cooling.		failed (JAIF, NISA, and TEPCO). Repairs	
	Unit 6 Assessment:		
	- Unit 6 is stat	ble with cooling capacity	recovered.
	Unit 6 Recommendations:		
-			
	 		(b)(4),(b)(5)
	Unit 6 Additional Considerations:		
	- 4		(b)(4),(b)(5)
	- X.		
	[Task Tracker 4254] M:\RSTJapanese Earth	iquake & Tsunami Responsel	Page 37 DRAFT - 1200 April 12, 2011 RST Assessment of Fukushima Daiichi



EY 537 of 942

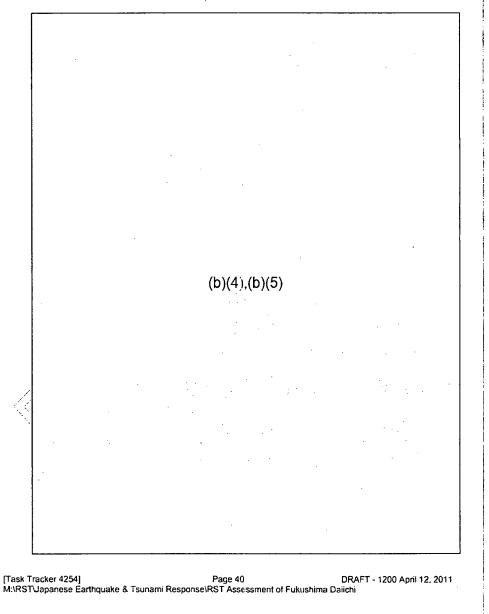
# **COMMON - SPENT FUEL POOL STATUS**

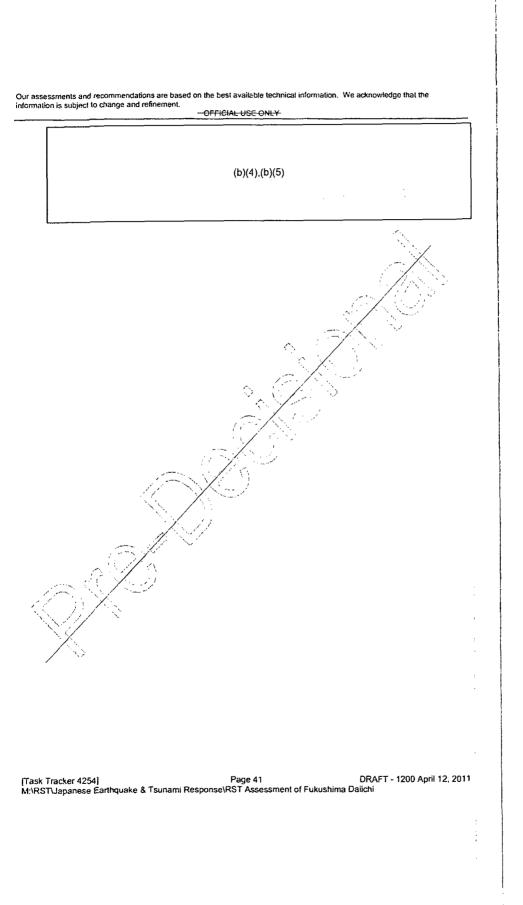
Amount of fuel:	6375 bundles	
Last transfer from Reactor:	No data	
Decay Heat (MW):	1.2 (MW) (b)(6)	
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)	
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data Full	
Water Injection Method and Source:	Normal cooling (NISA 3/24)	
Fuel Pool Water Temperature:	28.0°C (TECPO 4/5)	
Other:	the Alexandre and the second	
Common SFP_Assessment:	- A A	
Relatively stable.	775 .	
Common SFP Recommendations:	<u>/&gt;/</u>	
(b)(4),(b)(5)		
Common Additional Considerations:		
=	(b)(4),(b)(5)	
REFERENCES		
EPRI recommendations March 18, 2011 (b)(5)     SFP Criticality Potential, Kent Wood, March <u>2</u> 4, 2011     Spent Fuel Inventories Document		
ABBREVIATIONS:		
GEH – General Electric Hitachi INPO – Institute of Nuclear Power Operatic JAIF – Japan Atomic Industrial Forum NISA – Nuclear and Industrial Safety Agen		
[Task Tracker 4254] M:\RST\Japanese Earthquake & Tsunami Response	Page 39 DRAFT - 1200 April 12, 2011 \RST Assessment of Fukushima Daiichi	

TEPCO - Tokyo Electric Power Company

#### **ENCLOSURE 1**

1. EPRI recommendations March 18, 2011





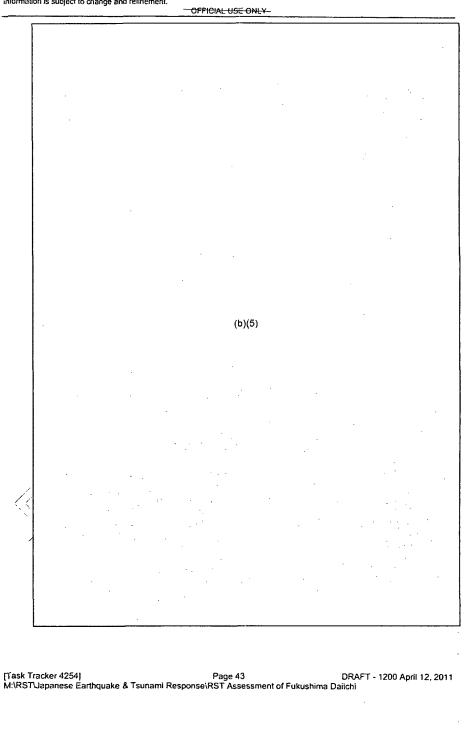
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EY 540 of 942

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 ENCLSOURE 2 SFP Criticality Potential, Kent Wood, March 24, 2011 . (b)(5)

[Task Tracker 4254] Page 42 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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 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

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.

# **ENCLOSURE 3**

#### Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

1		Reactor	Spent fuel pool
Unit 1			292
Unit 2			587
Unit 3		(b)(4)	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 1/1s Detailed Contents of Each Pool.

Page 44

From:	RST01 Hoc
Sent:	Tuesday, April 26, 2011 2:36 AM
To: Cc:	Hiland, Patrick; Skeen, David RST02 Hoc; OST01 HOC; Johnson, Michael; Uhle, Jennifer; Carpenter, Cynthia; Casto, Chuck; Reynolds, Steven; Kokajko, Lawrence; Correia, Richard; Tracy, Glenn; Dudes,
Subject: Attachments:	Laura Revision of RST Assessment Document to align w/ TEPCO Roadmap Document RST Assessment Document rev 2 4-26-2011.docx; April 23 roadmap assessment Rev 2 Skeen CN.docx

1

Pat & Dave,

(b)(5)

RST 01, See-Meng Wong, Kirby Scales.

EY 544 of 942

# -Official Use Only-

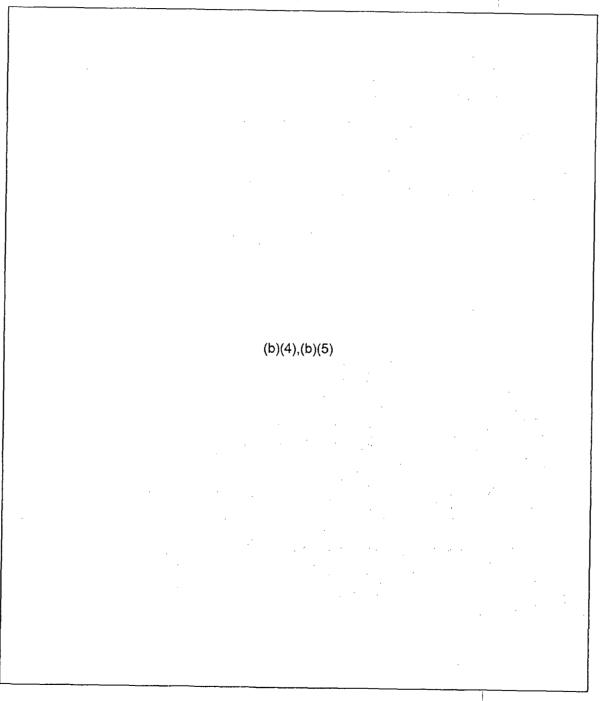
# RST Assessment of Fukushima Daiichi Units (REV 2),

į.

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.

RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2), Based on most recent available data and input from industry and government sources

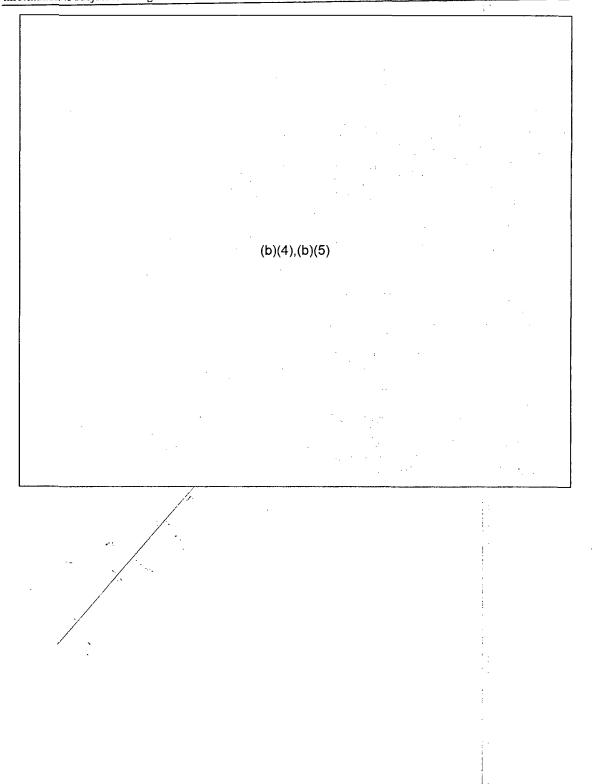


# -Official Use Only

# 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.



Page 2

# EY 546 of 942

## -Official Use Only

#### RST Assessment of Fukushima Daiichi Units (REV 2),

# Based on most recent available data and input from industry and government sources

11

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.

## 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.

Page 3

# **Official Use Only** 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.

# 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

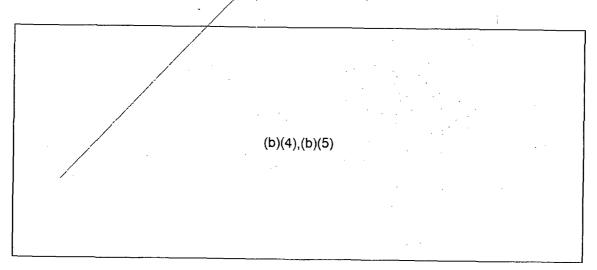
DW CAMS (Sv/hr) - INOP

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).



# -Official Use Only-

# RST Assessment of Fukushima Dalichi Units (REV 2),

# Based on most recent available data and input from industry and government sources

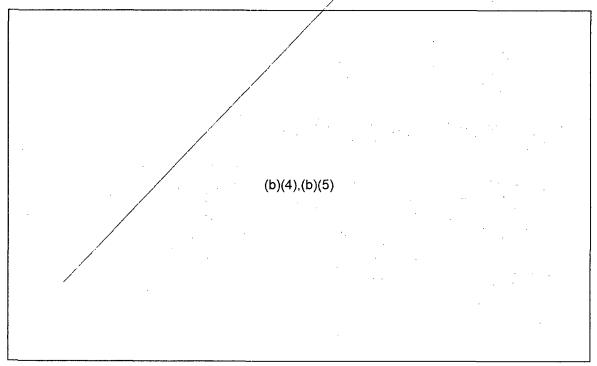
## 1400 April 22, 2011

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)
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)
Core Status: (b)(4),(b)(5) left enough salt to fill the lower p	(b)(4),(b)(5) [the volume of sea water injected to cool the core has lenum to the core plate. (GEH, INPO, Bettis, KAPL).

## 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.



Page 5

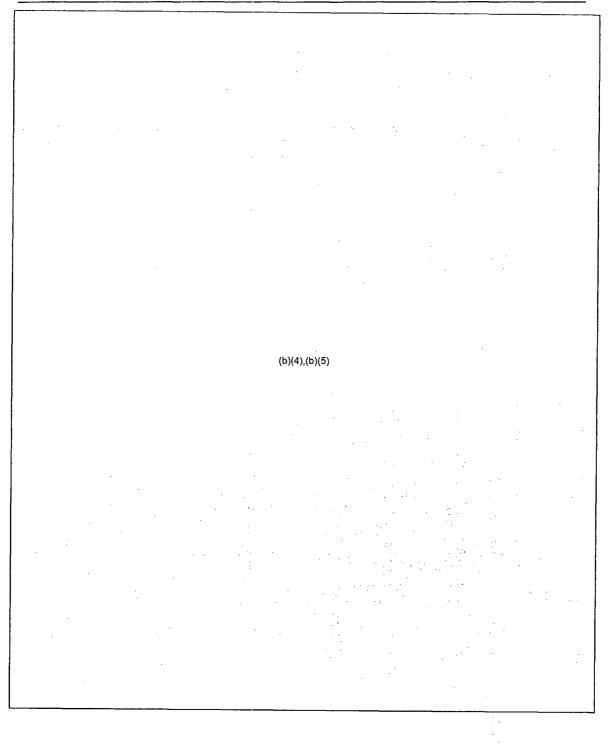
EY 549 of 942

# - Official Use Only-

# 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.



Page 6

EY 550 of 942

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.

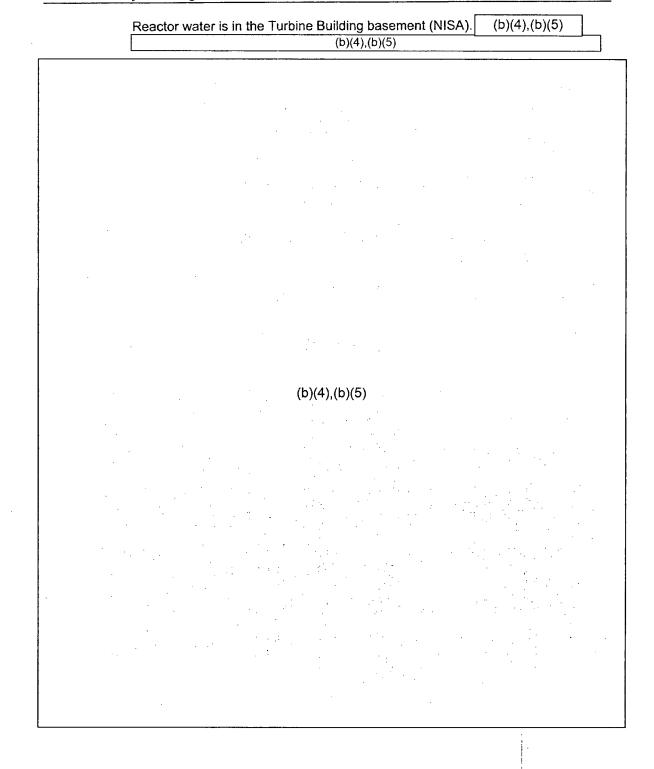
(b)(4),(b)(5)	
 Secondary Containment:       Severely damaged (hydrogen explosion).       (b)(5)         (b)(5)       shows entire fuel floor covered by grey-brown debris of building roof.	
(b)(4),(b)(5)	

Rad levels outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

Page 7

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.

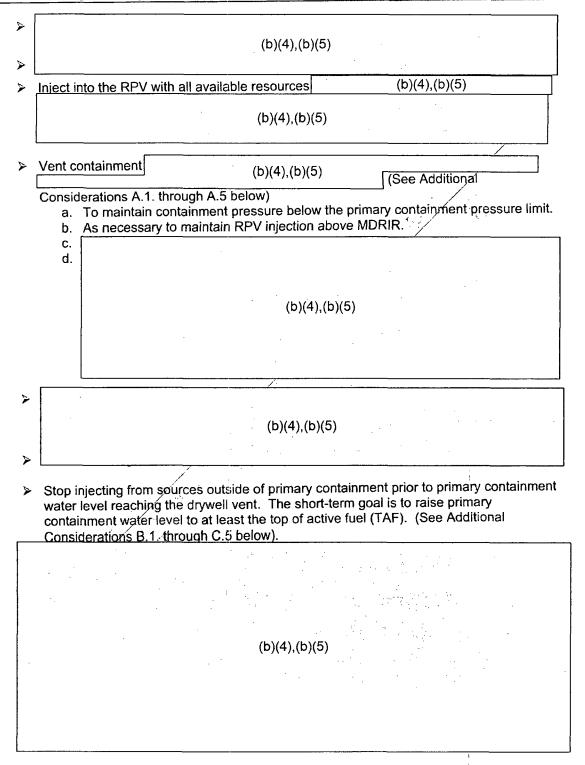


Page 8

EY 552 of 942

#### 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.



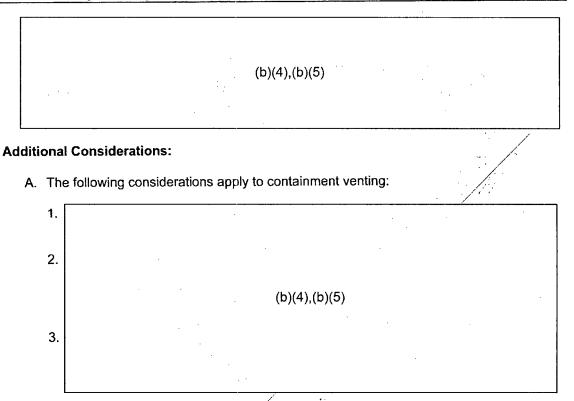
Page 9

EY 553 of 942

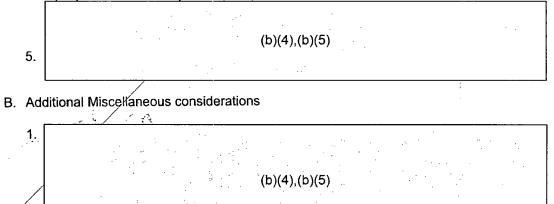
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1400 April 22, 2011
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Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.



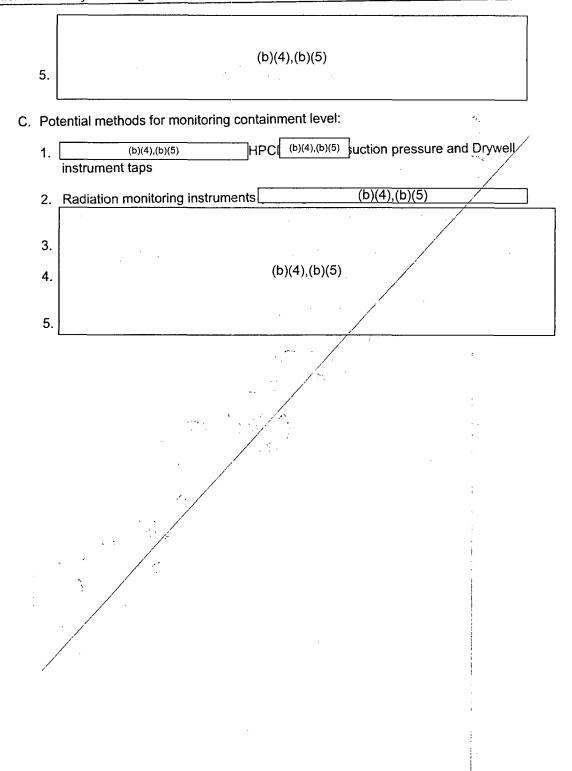
4. Spray water on steam plumes and planned containment vents for scrubbing effect



- 3. Ensure spent fuel pool level is maintained as full as possible.
- 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)

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.



# Official Use Only 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.

# 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: Criticality status: Fuel Pool Level:	No data No data No data	
Water Injection Method and Source: Period concr	dic fresh water injected via a hose off of a ete 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:		
(1	o)(4),(b)(5)	
Unit 1 SFP Recommendations:		
	(b)(4),(b)(5)	
Unit 1 SFP Additional Considerations:		
-	(b)(4),(b)(5)	

EY 556 of 942

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.

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(b)(4),(b)(5)	
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EY 557 of 942

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.

# 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

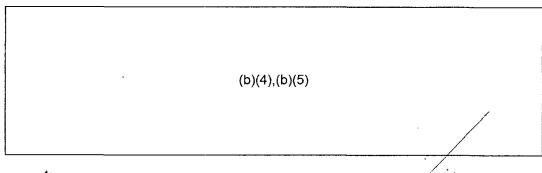
<u>Other Information</u>: External AC power has reached the unit, checking integrity of equipment before energizing.

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

EY 558 of 942

#### 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.



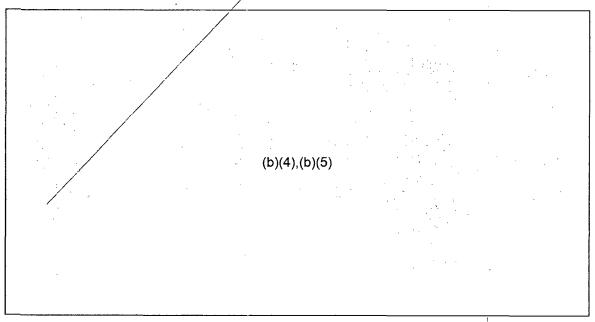
# Assessment:

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 (b)(4),(b)(5) Water flow past the fuel. flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core neight, though Natural circulation believed (b)(4),(b)(5)(D)(4),(D)(5 impeded by core damage.

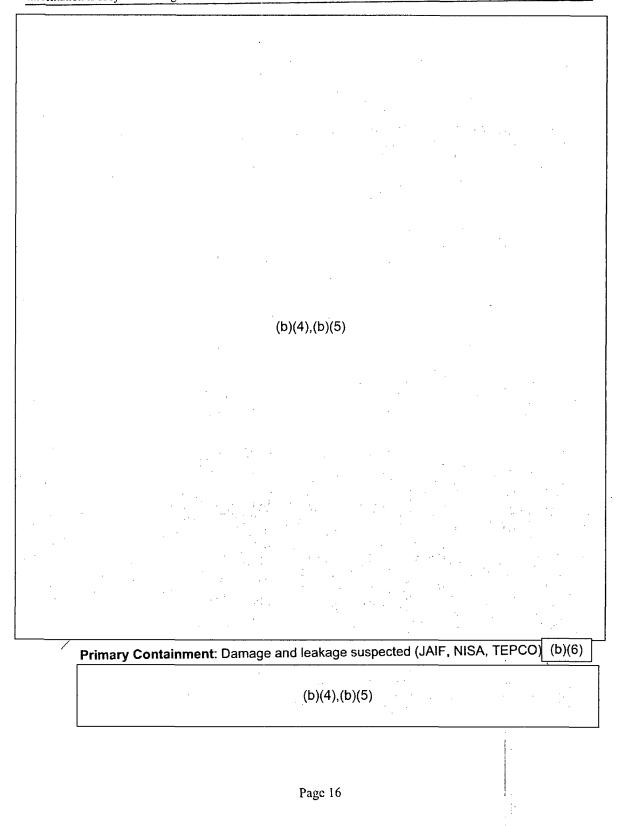
(b)(4),(b)(5) Vessel temperature readings are likely metal temperature which lags actual conditions.



EY 559 of 942

1400 April 22, 2011

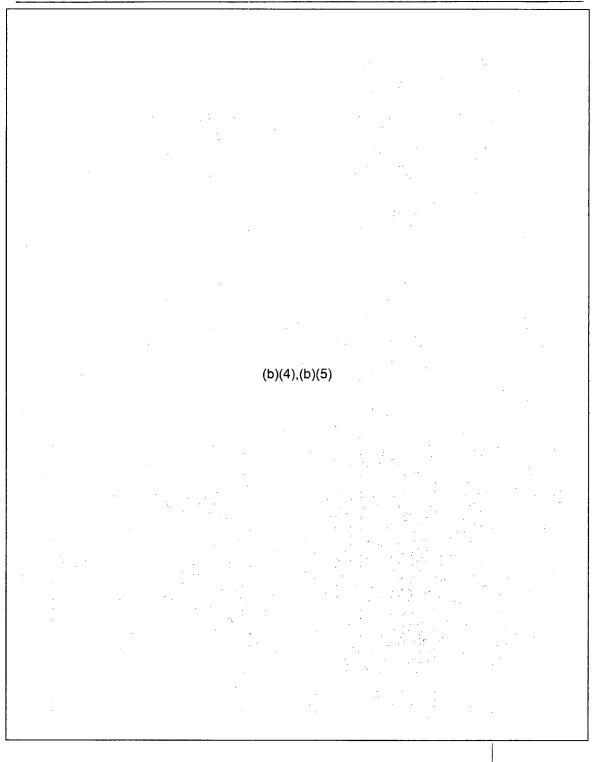
Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.



EY 560 of 942

1400 April 22, 2011

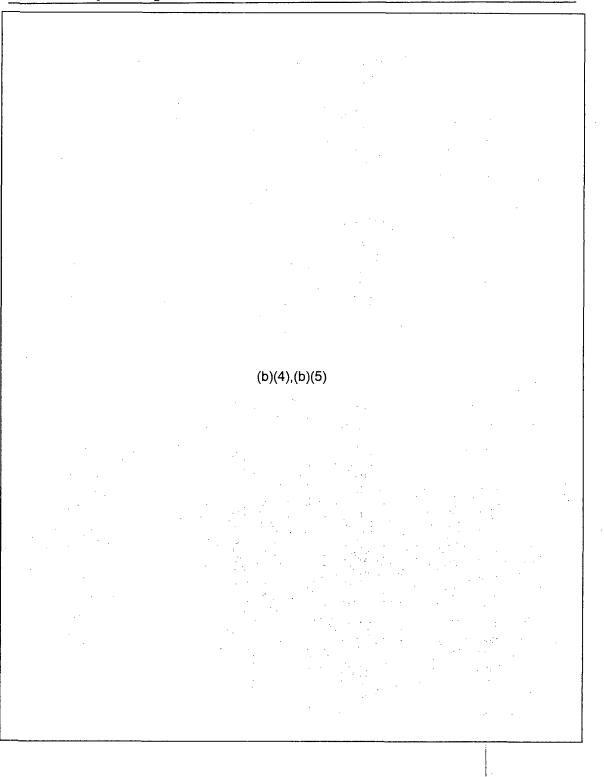
Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.



EY 561 of 942

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.

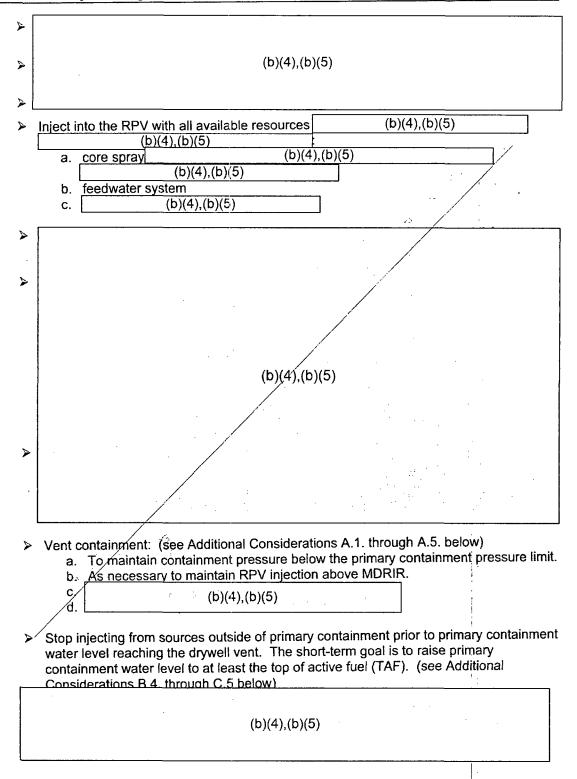


Page 18

EY 562 of 942



Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

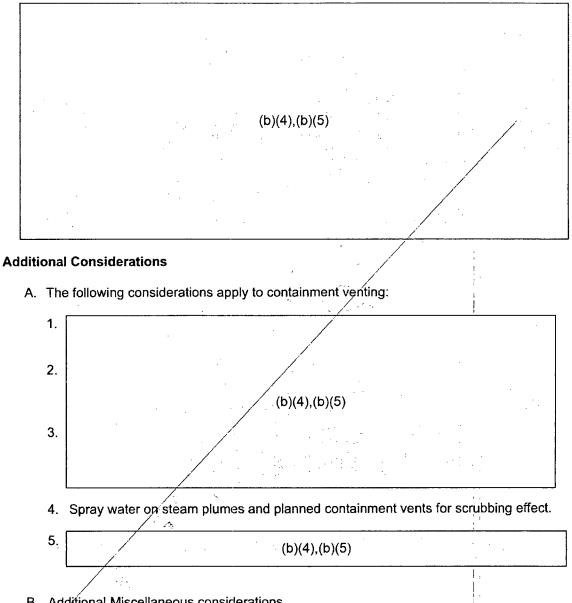


Page 19

EY 563 of 942

### 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. 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.

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.

4.	(b)(4)	,(b)(5)	
Pot	ential methods for monitoring containm (4),(b)(5]	ent level.	(b)(4),(b)(5)
1.		b)(4),(b)(5) suction pres	ssure and Drywell
2.	Radiation monitoring instruments	(b)(4),(b)(	5)
3.		(4) (5)(5)	
4.	(0)	(4),(b)(5)	
5.			
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# Official Use Only-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.

# **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 <u>,〔b)((</u> day	) evaporation rate	5240 gallons per
Fuel Pool Str	uctural Support Integrity:		(b)(4),(b)(5)	
Fuel Pool Lea Criticality stat Fuel Pool Lev	us:	No data No data Full		
Water Injectio	on Method and Source:	Fresh water inje injected 36 tons	ected to the spent f s on 4/7/11	uel pool. Last
Fuel Pool Wa	iter Temperature:	46°C (TEPCO	W12)	
Other:	External AC power has rea	ched the unit, che (b	<u>cking the integrity c</u> )(4),(b)(5)	of equipment
Unit 2 Asses	sment:			
	(	b)(4),(b)(5)		
Unit 2 Recon	nmendations:			
-/		(b)(4),(b)(5)		
- [				
Unit 2 Additio	onal Considerations:			;
-	· ·	(b)(4),(b)(5)	<u></u>	
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EY 566 of 942

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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.

# 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)

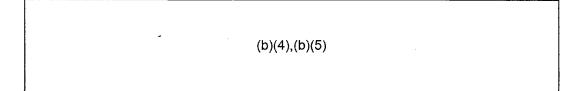
Page 23

EY 567 of 942

#### 

#### 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.



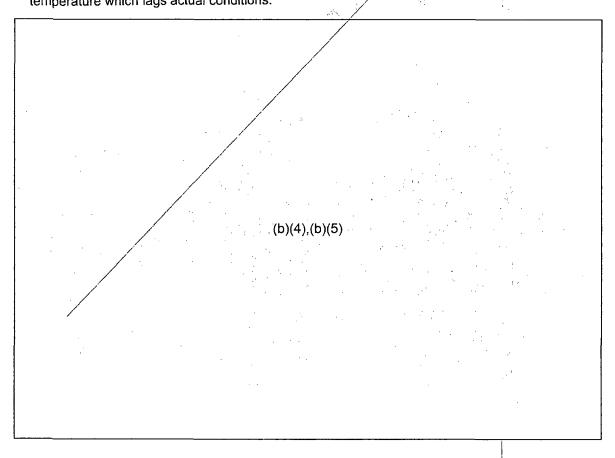
## Assessment:

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 neight, 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)

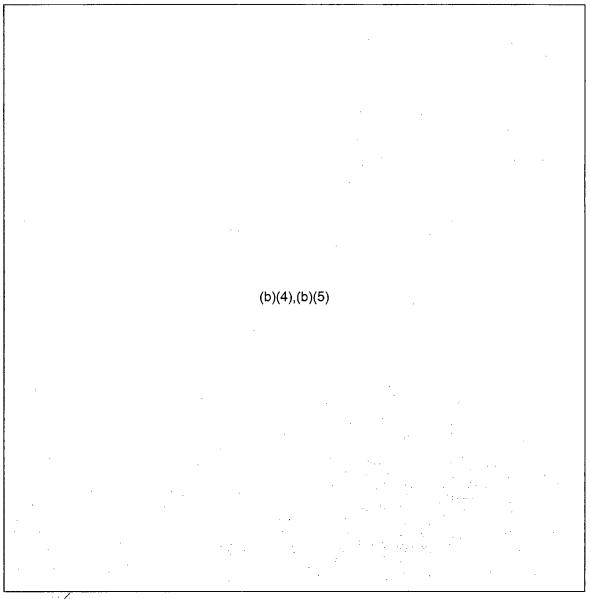
(b)(4),(b)(5) Vessel temperature readings are likely metal temperature which lags actual conditions.



EY 568 of 942

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.



# /Primary Containment: Damage suspected (RST, NISA, TEPCO)

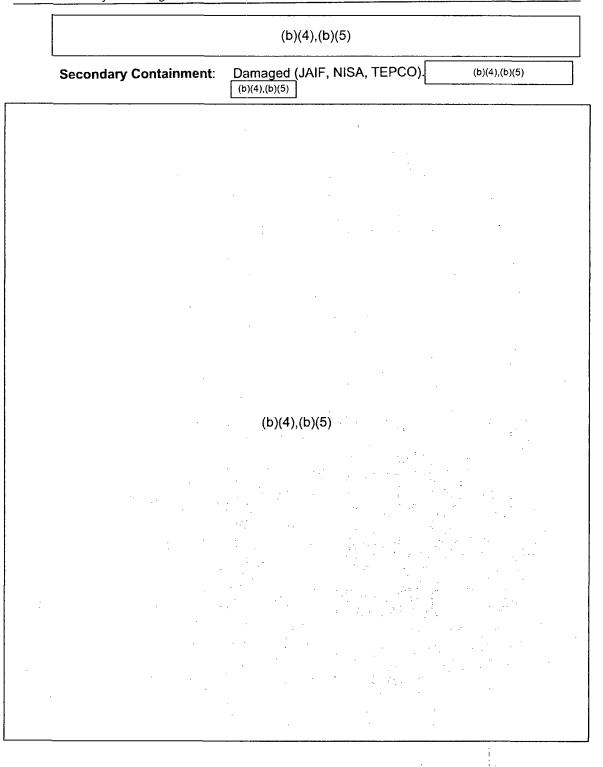
(b)(4),(b)(5)

Page 25

EY 569 of 942

# 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.



EY 570 of 942

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.

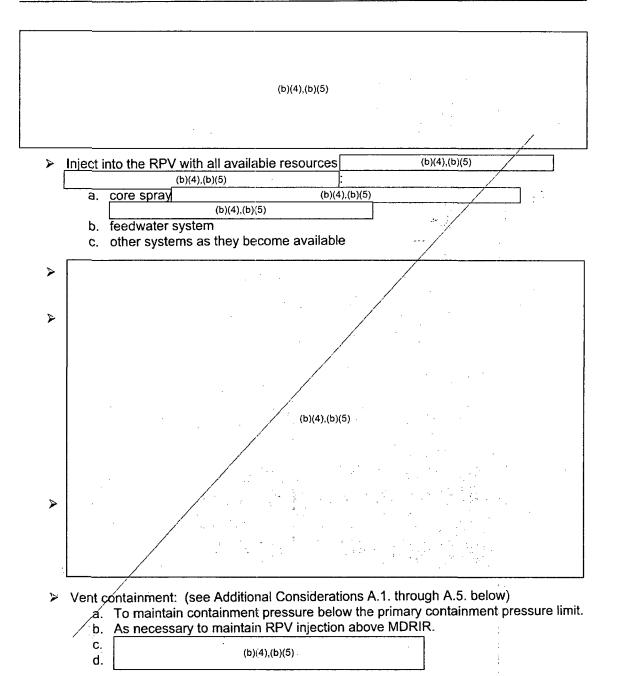
# (b)(4),(b)(5)

Page 27

EY 571 of 942

#### 1400 April 22, 2011

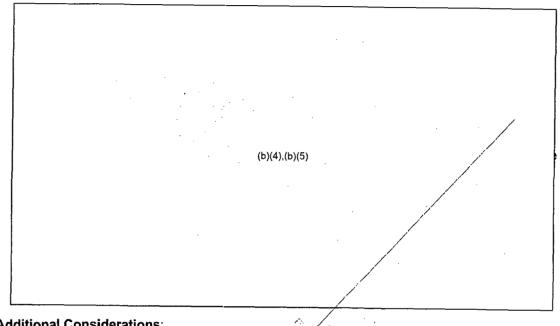
Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.



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).

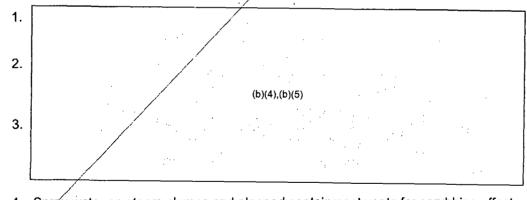
Page 28

Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

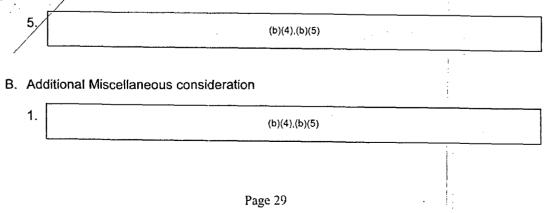


Additional Considerations:

A. The following considerations apply to containment venting:



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



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.

- 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)		
	otential methods for monitoring containment level.	(b)(4),(b)(5)	
1.	(b)(4),(b)(5) HPCI (b)(4),(b)(5) suction pres instrument taps	sure and Drywell	
2.	Radiation monitoring instruments (b)(4),(b)(5)	)	٦
3. 4.			
5.		1:	

1400 April 22, 2011

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Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

# 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: Criticality status: Fuel Pool Level:	No data No data 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)
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Page 31

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#### Official Use Only 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.

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	Page 32	4 4 4

#### - <del>Official Use Only -</del> RST Assessment of Fukushima Daiichi Units (REV 2),

## Based on most recent available data and input from industry and government sources

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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, N	ISA <u>,</u> TEPCO)
Core Cooling:	Not necessary (JAIF, NISA, TEPCO)	
Primary Containment:	Not applicable (JAIF, NISA, TEPCO)	

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

Rad Levels: No information

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

Page 33

EY 577 of 942

#### - Official Use Only-RST Assessment of Fukushima Daiichi Units (REV 2), Based on most recent available data and input from industry and government sources

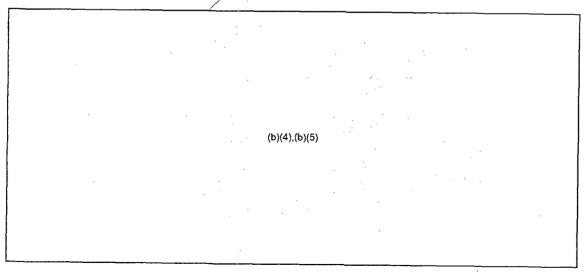
1400 April 22, 2011

Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

#### **UNIT 4 - SPENT FUEL POOL STATUS**

Amount of fue	ł:	1331 bundles
Last transfer f	rom Reactor:	548 bundles (December 5 to December 10, 2010)
Decay Heat (I	MWth):	2.3 MWth (b)(6) evaporation rate 20,000 gallons per day
Fuel Pool Stru	uctural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Lea Criticality state Fuel Pool Lev	us:	No data No data Low water level (b)(6) 4/1)
Water Injectio	n 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 Wa	ter Temperature:	30°C (JAIF 4/4)
Other:	External AC power has rea equipment before energizi	ached the unit, checking electrical integrity of ng.

Unit 4 Assessment:



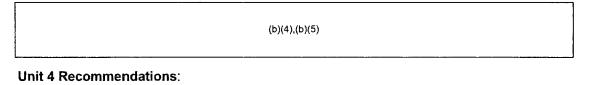
Page 34

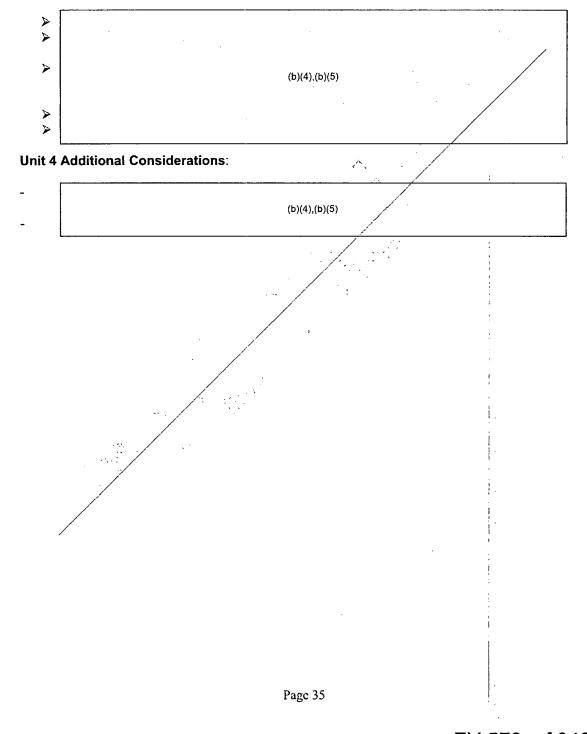
EY 578 of 942

#### -Official Use Only-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.





EY 579 of 942

#### -Official-Use-Only-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

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#### 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 hydro NISA, TEPCO)	ogen build up (JAIF,
Spent Fuel Pool:	946 bundles (JAIF); Temp: 34.70C1 (JAI Cooling capability recovered and function	
Other:	On offsite AC power (b)(67 3/28).	
ASSESSMENT:		÷
Unit five is stable.		
RECOMMENDATIONS:		: !
> Monitor		
		• •

#### Official Use Only-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.

#### **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: Criticality status: Fuel Pool Level:	No data No data Full	
Water Injection Method and Source:	Fuel pool cooling	
Fuel Pool Water Temperature:	37.9°C (JAIF 4/5)	
Pool Cooling temporarily lost	the unit, Unit 6 diesel generators available. Fuel when pump failed (JAIF, NISA, and TEPCO). ump used for fuel pool cooling.	
Unit 5 Assessment:		
<ul> <li>Unit 5 is stable with cooling capacity</li> </ul>	recovered.	
Unit 5 Recommendations:		
> > > >	5)	
Unit 5 Additional Considerations:		
-	(b)(4),(b)(5)	

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1400 April 22, 2011

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#### 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)
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 (16) 3/28)
ASSESSMENT:	
Unit Six is stable.	
RECOMMENDATIONS:	
Monitor	

#### -Official Use Only 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.

#### **UNIT 6 - SPENT FUEL POOL STATUS**

Amount of fuel:

Last transfer from Reactor:

Decay Heat (MW):

Fuel Pool Structural Support Integrity: Not da

Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level: 184 bundles (August 10-25 2010)

876 bundles

Not damaged (JAIF 4/4)

No data No data Full

(NISA 3/25)

0.7 (MW)

Water Injection Method and Source:

Fuel Pool Water Temperature:

28.5°C (TECPO 4/5)

Residual heat removal in fuel pool cooling mode

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:

AAA

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

Unit 6 Additional Considerations:

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

# Official Use Only 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.

#### **COMMON - SPENT FUEL POOL STATUS**

Amount	t of fuel:	6375 bundles	
Last tra	nsfer from Reactor:	No data	
Decay I	Heat (MW):	1.2 (MW)	
Fuel Po	ool Structural Support Integrity:	Not damaged (JAIF 4/4)	
Criticali	ool Leak Integrity: ty status: ool Level:	No data No data Full	
Water I	njection Method and Source:	Normal cooling (NISA 3/24)	2
Fuel Po	ool Water Temperature:	28.0°C (TECPO 4/5)	<b>1</b>
Other:			: 
Comm	on SFP Assessment:		:
Relative	ely stable.		- - - -
Comm	on SFP Recommendations:		r :
	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	1
AA	(b)(4),(b	)(5)	• •
>	(b)(4),(b on SFP Additional Considerations		
>			
>   Comm - -		s:	
Comm - - ABBRE GEH - INPO - JAIF - NISA -	on SFP Additional Considerations	s: (b)(4),(b)(5) pns	
Comm - - ABBRE GEH - INPO - JAIF - NISA -	on SFP Additional Considerations	s: (b)(4),(b)(5) pns	

Page 40

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#### April 25, 2011

(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 decisionmaking 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:

## EY 585 of 942

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- 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.
  - 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 subcriticality 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 noncombustible atmosphere in the primary containment.
  - h. Establish reasonable assurance of SFP integrity.

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- 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 subcriticality 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 <u>NRC</u> has included suggestions regarding organizational issues that, if considered, may enable

## EY 587 of 942

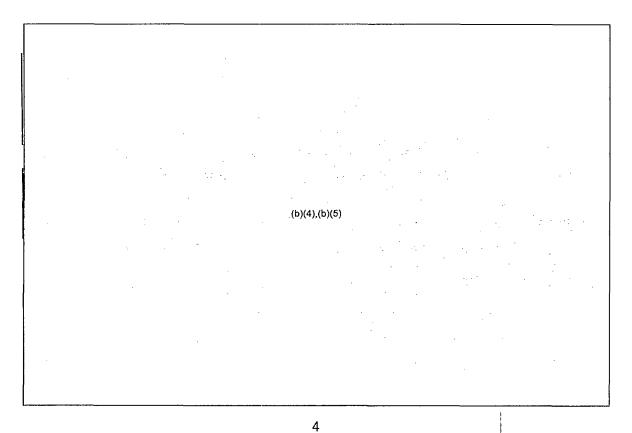
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more efficient and effective implementation of the Roadmap. These organizational issues can also improve the safety of the facility.

#### **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 <u>countermeasures</u> 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.



EY 588 of 942

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	(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 <u>will</u> 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.

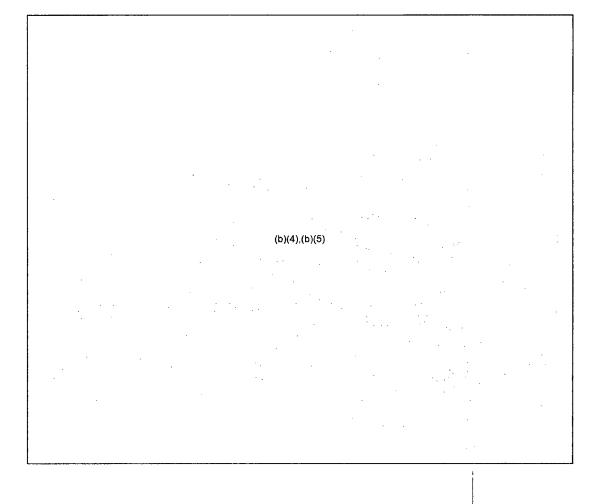
(b)(4),(b)(5)

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.



6

EY 590 of 942

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(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.

(Unit F1 and Unit F3)

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)

## EY 591 of 942

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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 of 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)

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## 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

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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

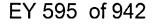
Countermeasure [20]: tolerance evaluation is especially needed for F4. A certain level of seismic tolerance has been confirmed.

#### 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 subcriticality in spent fuel pool,



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- 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.

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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.

EY 597 of 942

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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.

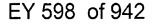
Factor j. analysis:

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



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#### 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:

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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 Dalichi 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

16

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- (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)

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- 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
То:	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 Dailchi 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 <u>RST01.Hoc@nrc.gov</u>.

John Thorp RST Chronologist Evening Shift, 3/24/2011

EY 603 of 942

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 <u>it at base</u>. Japan also accepted and plans are being made for the U.S. Navy to provide two water barges as <u>well</u>. 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.

-OFFICIAL USE ONLY

#### \_\_\_OFFICIAL USE ONLY

MEMORANDUM TO:	Chairman Jaczko
FROM:	Margaret M. Doane, Director Office of International Programs
SUBJECT:	(b)(5)
	(b)(5)

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EY 605 of 942

From: Sent: To: Subject: Jaczko, Gregory <Gregory.Jaczko@nrc.gov> Thursday, March 24, 2011 11:45 PM Coggins, Angela; Batkin, Joshua; Pace, Patti 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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<ul> <li>Unattended Support - log in to customers' computers after hours</li> <li>Unlimited Sessions - instantly support customers anytime, anywhere for one flat fee</li> <li>Multitasking - support up to 8 customers at once</li> <li>File Transfer - move large files directly to customers' desktops</li> </ul> <u>Try GoToAssist Express FREE for 30 days</u> and see how much time you can save with fast, efficient remote support.	
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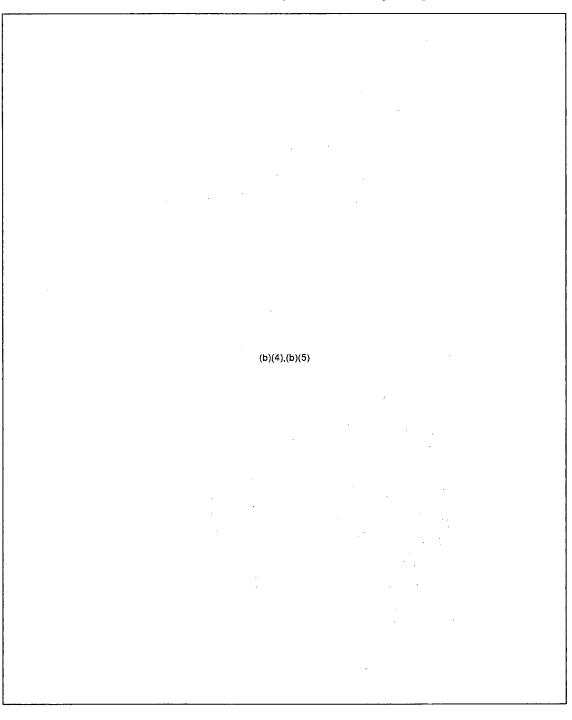
#### -Official Use Only-RST Assessment of Fukushima Daiichi Units (REV 2),

### 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.

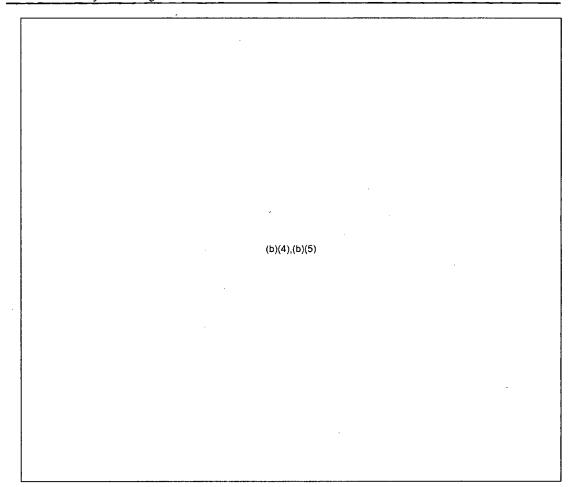
RST ASSESSMENT OF FUKUSHIMA DAIICHI UNITS (REV 2), Based on most recent available data and input from industry and government sources



#### --Official Use Only--RST Assessment of Fukushima Daiichi Units (REV 2), Based on most recent available data and input from industry and government sources

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#### -Official Use Only-RST Assessment of Fukushima Daiichi Units (REV 2), Based on most recent available data and input from industry and government sources

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#### 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>

<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.

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#### 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

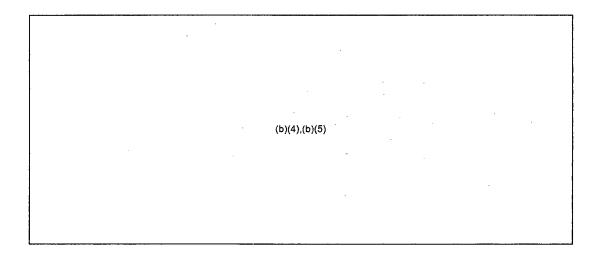
DW CAMS (Sv/hr) - INOP

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).



Page 4

EY 611 of 942

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#### 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)	
failed (GEH).	(b)(4).(b)(5)		Recirculation pump seals have likely

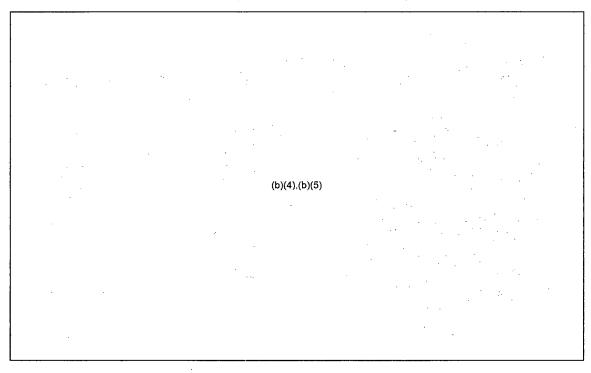
Core Status:	(b)(4),(b)(5)
(b)(4),(b)(5)	the volume of sea water injected to cool the core ha

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.



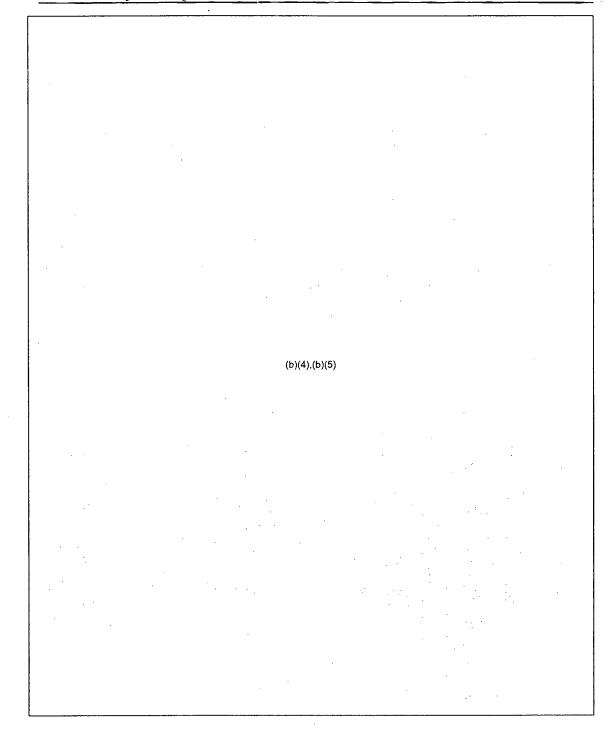
Page 5

EY 612 of 942

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1400 April 22, 2011

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Page 6

EY 613 of 942

#### -Official Use Only-RST Assessment of Fukushima Daiichi Units (REV 2), most recent available data and input from industry and government

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.

Secondary C	ontainmen	t: Severely	damaged ( iel floor co	(hydrogen ex vered by gre	plosion). y-brown debris	(b)(5)
roof.	·				,	
		(b)(4	),(b)(5)			
		(v)(+	,,(0),(0)		•	
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Rad levels outside plant: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

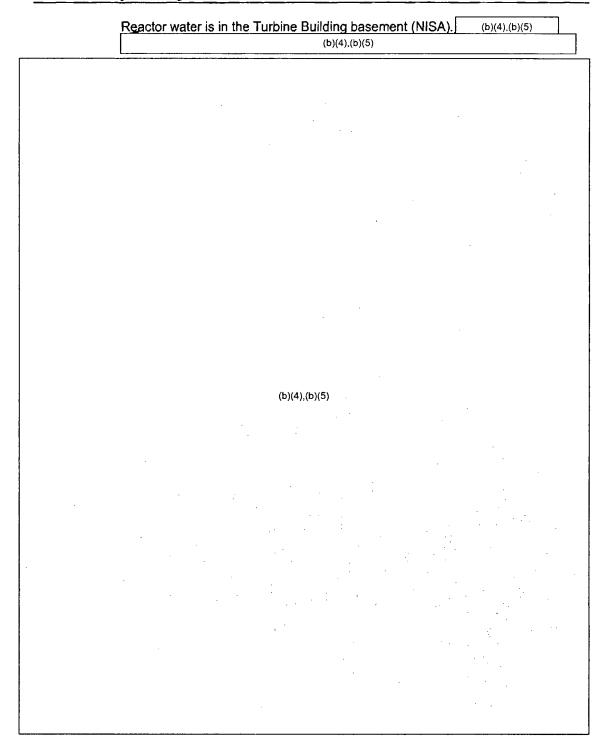
Page 7

EY 614 of 942

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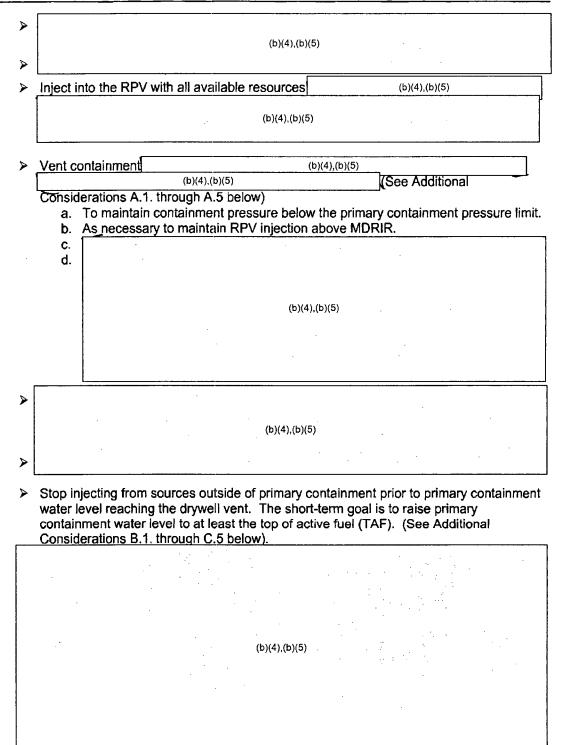


EY 615 of 942

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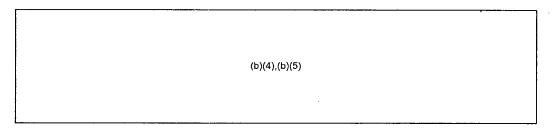


Page 9

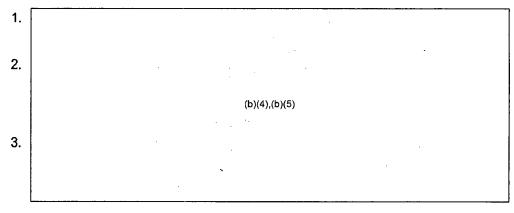
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## 1400 April 22, 2011

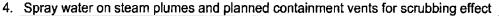
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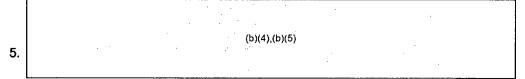


# Additional Considerations:

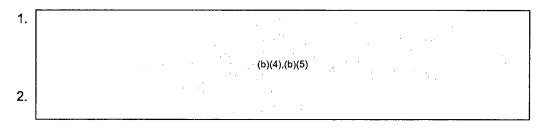


A. The following considerations apply to containment venting:





# B. Additional Miscellaneous considerations



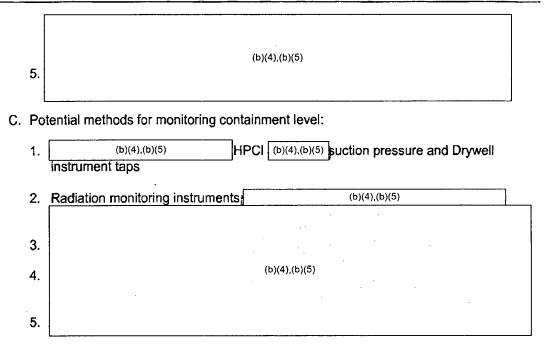
- 3. Ensure spent fuel pool level is maintained as full as possible.
- Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel (b)(4),(b)(5)

Page 10

# Official Use Only-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

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# 

# 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.

# 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: Criticality status: Fuel Pool Level: Water Injection Method and Source: Period concre	No data No data No data ic fresh water injected via a hose off of a te 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)
Water Injection Method and Source: Period concre Fuel Pool Water Temperature: 18°C ( Power Status:	ic fresh water injected via a hose off of a te pumper truck arm 3/31 0815) Electric power available; equipment testing in progress (JAIF, NISA, TEPCO) JT, a hydrogen explosion occurred during venting.

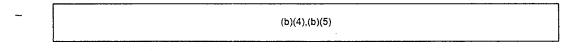
# Unit 1 Assessment:

	(b)(4),(b)(5)		
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# Unit 1 SFP Recommendations:

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	(b)(4),(b)(5)
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# **Unit 1 SFP Additional Considerations:**



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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)

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# Based on most recent available data and input from industry and government sources

1400 April 22, 2011

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# 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)

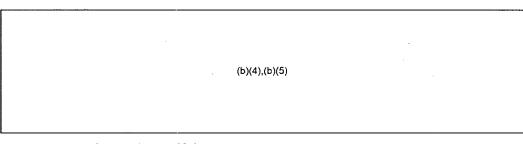
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	· · · · · · · · ·	· · ·
- -		
	·	(b)(4),(b)(5)
		<u></u>
	(b)(4),(b)(5)	Recirculation pump seals have likely failed (GEH).

# -Official Use Only-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.



**RPV Structural Integrity**: Unknown

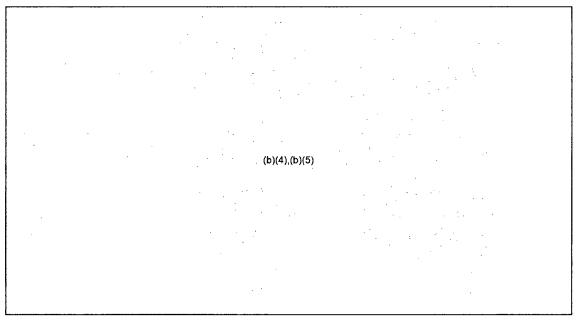
# Assessment:

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 <u>lower temperatures reported indicate that</u> 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 cooli	ng 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 vess	el to 2/3 core height, though
	(b)(4).(b)(5)	Natural circulation believed
impeded by core damage.		
(b)(4),(b)(5) Vessel temp	erature readings are likely metal tempe	rature which lags actual

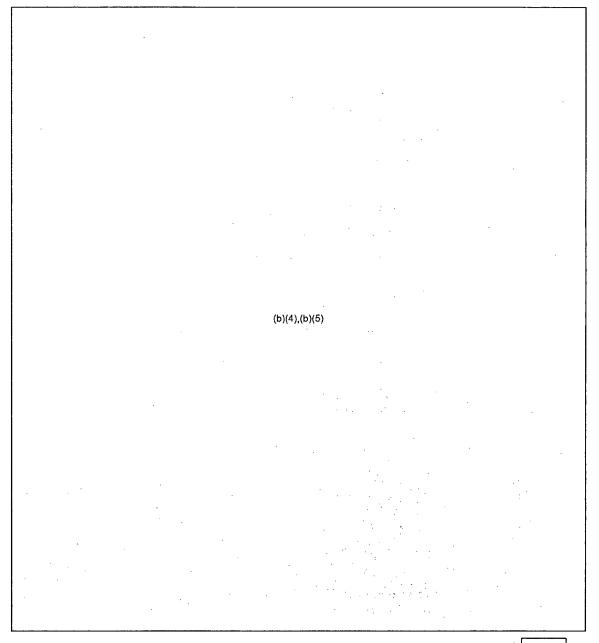
conditions.



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1400 April 22, 2011

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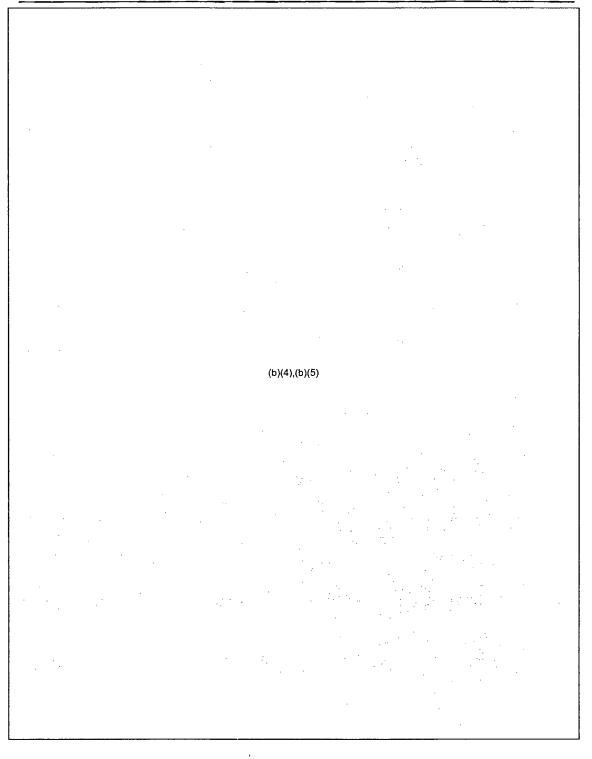


Primary Containment: Damage and leakage suspected (JAIF, NISA, TEPCO) (b)(6)

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

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EY 624 of 942

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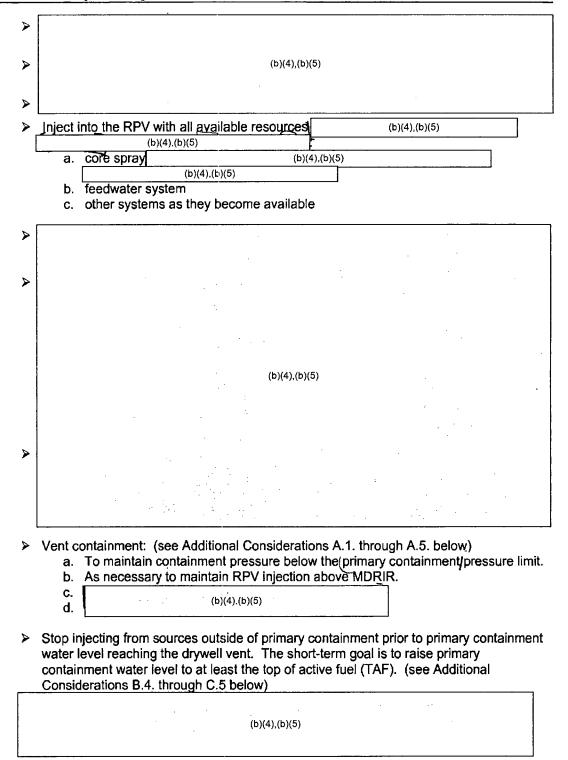
(b)(4).(b)(5)

EY 625 of 942

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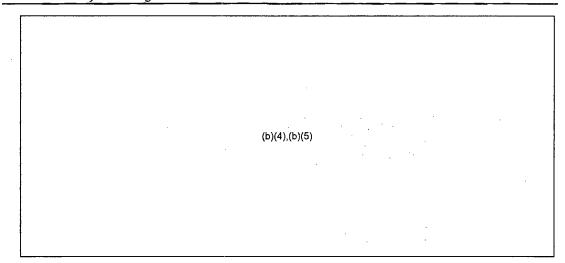
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EY 626 of 942

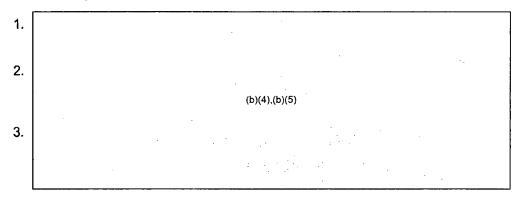
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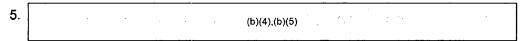


# **Additional Considerations**

A. The following considerations apply to containment venting:



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



- 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.

EY 627 of 942

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	4.		(b)(4),(b)(5)
C.		bitential methods for monitoring cont	ainment level. (b)(4),(b)(5)
	1.	(b)(4),(b)(5) Instrument taps	PC[ (b)(4),(b)(5) suction pressure and Drywell
	2.	Radiation monitoring instruments	(b)(4),(b)(5)
	3.		
	4.		(b)(4),(b)(5)
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# --Official Use Only-RST Assessment of Fukushima Dalichi Units (REV 2),

# Based on most recent available data and input from industry and government sources

1400 April 22, 2011

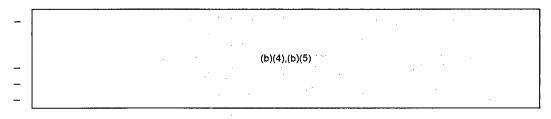
Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

# **UNIT 2 - SPENT FUEL POOL STATUS**

Amount of fue	ł:	587 bundles
Last transfer f	rom 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 Stru	ctural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:		No data No data Full
Water Injectio	n Method and Source:	Fresh water injected to the spent fuel pool. Last injected 36 tons on 4/7/11
Fuel Pool Wat	ter Temperature:	46°C (TEPCO 4/12)
Other: External AC power has react before energizing.		hed the unit, checking the integrity of equipment (b)(4),(b)(5)
Unit 2 Assess	ment:	

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

# Unit 2 Recommendations:



# Unit 2 Additional Considerations:

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

# -Offici<del>al Use Only-</del> 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

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# UNIT THREE CORE

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

Control Parameter Assessment: (As of 0700, 4/12/11)

<u>RPV Pressure (MPag)</u> A – (-.019), steady (-2.8 psig) B – (-0.079), steady (-11.5 psig) <u>RPV Temperature (°C)</u> Bottom Head – 105, steady (222°F) Feedwater Nozzle – 105.4 and lowering (221.7°F) <u>PCV Pressure (MPaa)</u> 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)

#### -Official Use Only-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

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

<b>RPV</b>	Structural	Integrity:	Unknown
	onaotarai		Quint Quint

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.

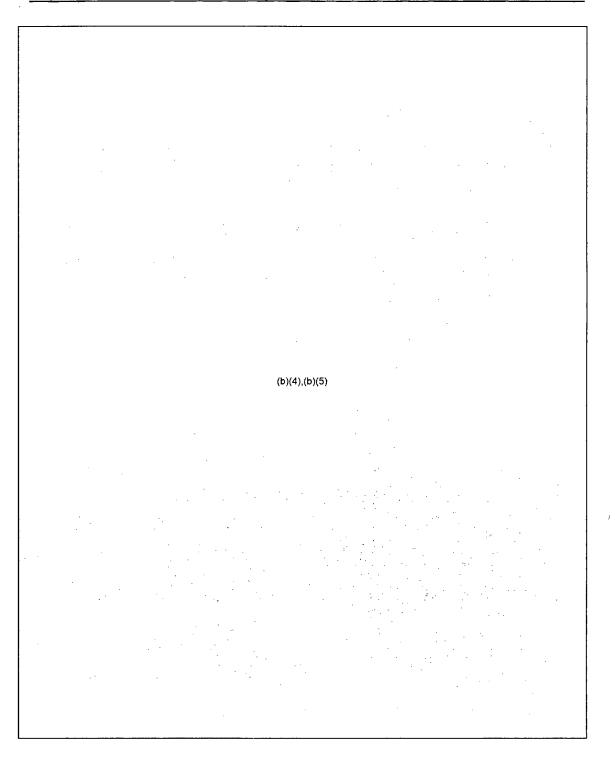
(b)(4),(b)(5)

Page 24

# --Official Use Only-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

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# -Official Use Only-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

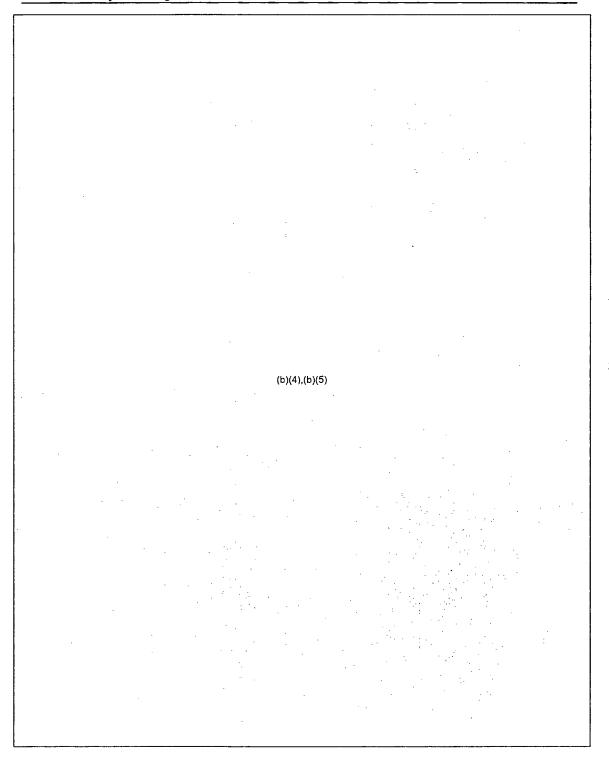
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	(b)(4),	(b)(5)		
Secondary Containment:	Damaged (JAIF (b)(4),(b)(5)	, NISA, TEPCO).	(b)(4),(b)(5)	
· · ·		· · · · ·		
	·	:		
	(b)(4),(b)(5)			

# Official Use Only RST Assessment of Fukushima Daiichi Units (REV 2), Based on most recent available data and input from industry and government sources

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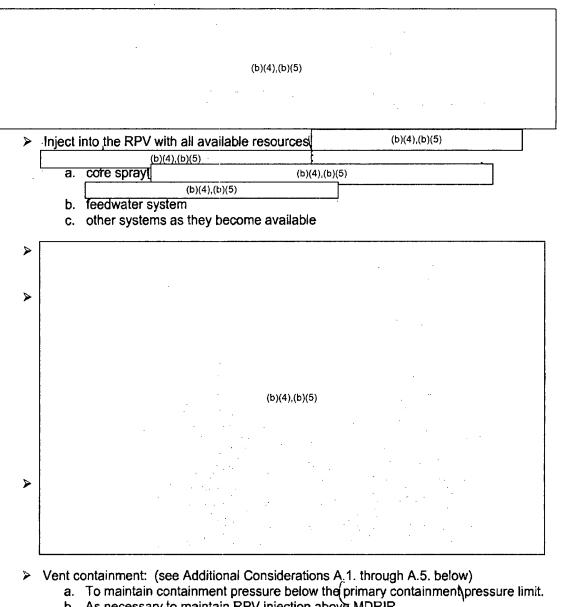


EY 634 of 942

#### Official Use Only RST Assessment of Fukushima Daiichi Units (REV 2), Based on most recent available data and input from industry and government sources

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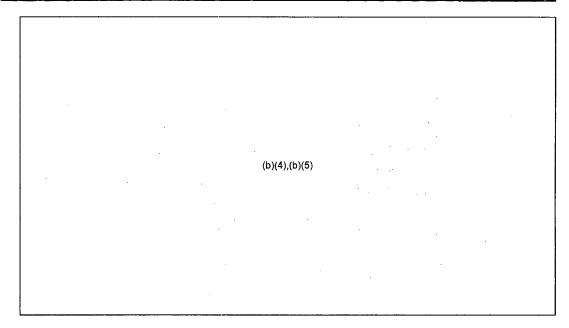


- b. As necessary to maintain RPV injection above MDRIR.
  c. (b)(4),(b)(5)
  d. (b)(4),(b)(5)
- Stop injecting from sources outside of primary containment prior to primary containment water level reaching the drywell vent. The short-term goal is to raise primary containment water level to at least the top of active fuel (TAF). (see Additional Considerations B.4. through C.5. below).

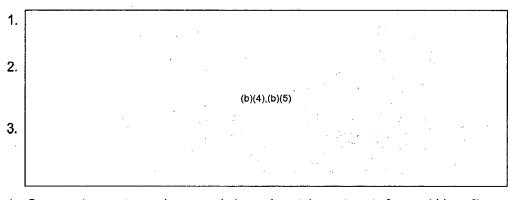
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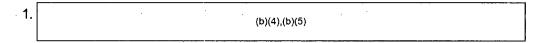
# Additional Considerations:



A. The following considerations apply to containment venting:

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

# B. Additional Miscellaneous consideration



# 

# 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.

- 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)	
	tential methods for monitoring containment level.	(b)(4),(b)(5)
1.	(b)(4),(b)(5) [HPCI (b)(4),(b)(5) instrument taps	suction pressure and Drywell
2.	Radiation monitoring instruments	(b)(4),(b)(5)
3.		
4.	(b)(4),(b)(5)	
5 <sub>1</sub>		

# --Official-Use-Only-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

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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, 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: Criticality status: Fuel Pool Level:	No data No data 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)

#### Official Use Only RST Assessment of Fukushima Daiichi Units (REV 2), ost recent available data and input from industry and covernment

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

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# Official Use Only-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

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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 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).

# Official Use-Only RST Assessment of Fukushima Daiichi Units (REV 2),

# Based on most recent available data and input from industry and government sources

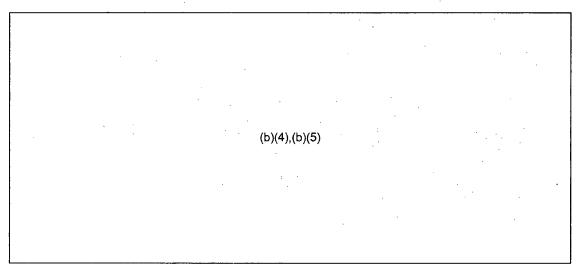
1400 April 22, 2011

Our assessments and recommendations are based on the best currently available technical information. This information is subject to change and refinement.

# **UNIT 4 - SPENT FUEL POOL STATUS**

Amount of fu	el:	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 Str	uctural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)
Fuel Pool Lea Criticality stat Fuel Pool Lev	tus:	No data No data Low water leve( (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 Wa	ater Temperature:	30°C (JAIF 4/4)
Other: External AC power has reach equipment before energizing.		ched the unit, checking electrical integrity of ig.

Unit 4 Assessment:

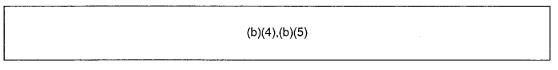


EY 641 of 942

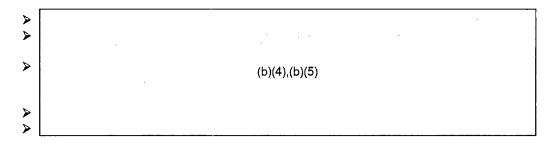
# ---Official Use Only-RST Assessment of Fukushima Daiichi Units (REV 2), Based on most recent available data and input from industry and government sources

# 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.



# Unit 4 Recommendations:



# **Unit 4 Additional Considerations:**

<b>-</b> .	(b)(4) (b)(5)
-	(b)(4),(b)(5)

# Official Use Only 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

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# 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

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# -Offici<del>al Use Only</del>-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.

# **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: Criticality status: Fuel Pool Level:	No data No data Full
Water Injection Method and Source:	Fuel pool cooling
Water Injection Method and Source: Fuel Pool Water Temperature:	Fuel pool cooling 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)

# -Official-Use-Only-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

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# 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) \$/28)		
ASSESSMENT:			
Unit Six is stable.			
RECOMMENDATIONS:			

> Monitor

Page 38

EY 645 of 942

# Official Use Only– 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

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# **UNIT 6 - SPENT FUEL POOL STATUS**

Amount of fue	el:	876 bundles
Last transfer t	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 Lea Criticality stat Fuel Pool Lev	us:	No data No data Full
Water Injectio	n Method and Source:	Residual heat removal in fuel pool cooling mode (NISA 3/25)
Fuel Pool Wa	ter 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 (IAIE, NISA, and TEPCO)	

# 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)
۶	

# **Unit 6 Additional Considerations:**

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

#### -Official Use Only RST Assessment of Fukushima Daiichi Units (REV 2), next recent available data and input from inductry and governmen

# Based on most recent available data and input from industry and government sources

1400 April 22, 2011

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# **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: Criticality status: Fuel Pool Level:	No data No data 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:**

A A

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

# **Common SFP Additional Considerations:**

-

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

# **ABBREVIATIONS:**

GEH – General Electric Hitachi

INPO – Institute of Nuclear Power Operations

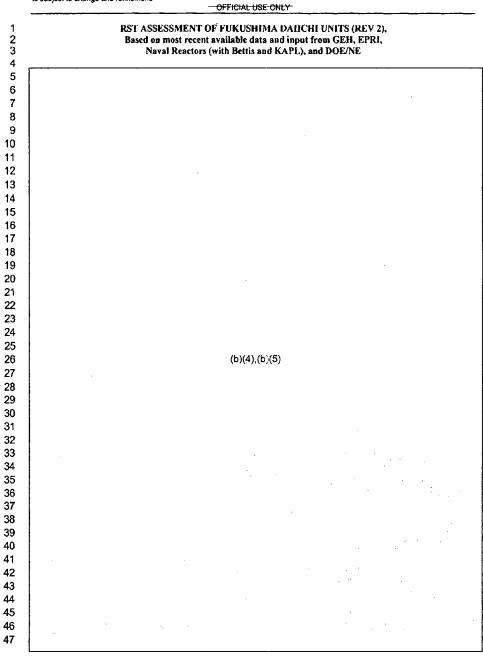
JAIF - Japan Atomic Industrial Forum

NISA - Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company

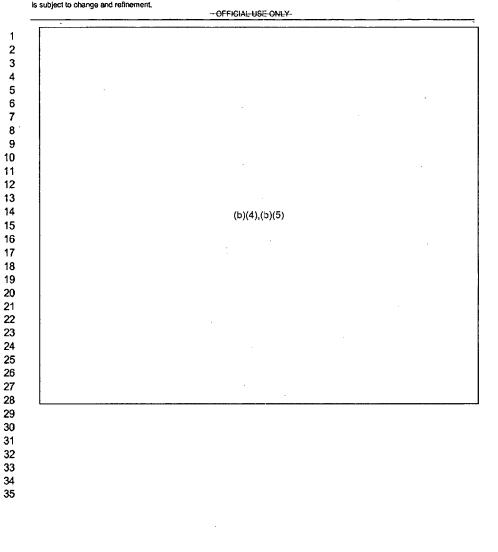
Page 40

EY 647 of 942



[Task Tracker 4254] Page 1 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 648 of 942



[Task Tracker 4254] Page 2 DRAFT - 1200 April 12, 2011 M:RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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1	
2	
3	Definitions
4	
5	Minimum Debris Retention Injection Rate (MDRIR) is the lowest RPV injection rate at which it is
6	expected that core debris will be retained in the RPV when RPV water level cannot be determined
7	to be above the bottom of active fuel. It is utilized to ensure that injection into the RPV is
8	sufficient to remove decay heat from core debris.
9	
10	Minimum Debris Submergence Level (MDSL) is the lowest primary containment water level at
11	which it is expected that ex-vessel core debris on the drywell floor will be adequately submerged.
12	It is utilized to preserve primary containment integrity following RPV breach by core debris.
13	
14	Minimum Drywell Spray Flow (MDSF) is the lowest spray flow that assures uniform
15	circumferential spray distribution within the drywell. Flow rates less than this will not perform
16	the spray function but only a flooding function. The MDSF is typically in thousands of gallons
17	per minute.
18	

19

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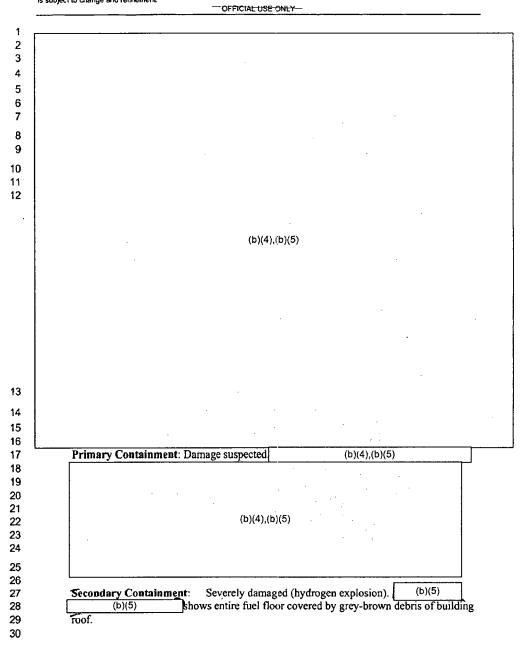
[Task Tracker 4254] Page 3 DRAFT - 1200 April 12, 2011 M:RSTUapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi

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1	UNIT ONE CORE
2 3   4	ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH)
5 6	Control Parameter Assumptions: (As of 0700, 4/12/11)
7	RPV Pressure (Mpag)
8	A – 0.416, steady (60.3 psig)
9	B – 0.908, rising (131.7 psig)
0	RPV Temperature (°C)
1	Bottom Head – 119, steady (246.2°F)
2	Feedwater Nozzle - 216.2 and lowering (421.2°F)
3	PCV Pressure (MPaa)
4	DW – 0.19 (27.6 psia)
5	SC – 0.165 (23.9 psia) rising
6	DW CAMS (Sv/hr) – INOP
7	S/C CAMS (Sv/hr) - 10.8 (1080 rem/hr) lowering
8	Containment Atmosphere - Inert, Nitrogen injection in progress
9	Other Information:
20	On offsite AC power – Control Room lighting for U-1, 2, 3, & 4 (JAIF, 4/1)
21 22	External AC power to the Main Control Room of U-1 became available at 11:30 JDT
3	3/24/2011. Lighting in Main Control Room is operating in U-1. (b)(4).(b)(5)
4 5	(b)(4),(b)(5)
6	
7 8	(b)(4),(b)(5)
8 9	
0	
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2	
3 4	
5	(b)(4),(b)(5)
6 7	
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[Task Tracker 4254] Page 4 DRAFT - 1200 April 12, 2011 M:RSTUapanese Earthquake & Tsunami Response:RST Assessment of Fukushima Dalichi .

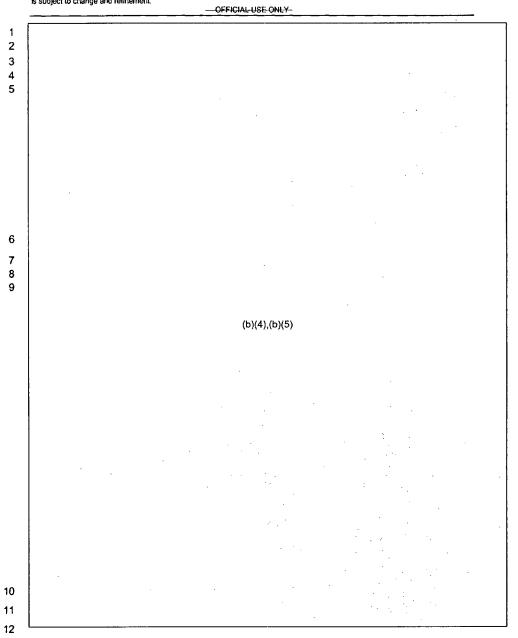
		(b)(4),(b)(5)	
	Reactor water level	(b)(4),(b)(5)	
	(b)(4),(b)(5) likely_failed (GEH).	) Recirculation pu	mp seals have
	inkely_tailed (GEH).		
	Core Status:	(b)(4),(b)(5)	
	(b)(4),(b)(5)	The volume of sca water injected to a	cool the core has le
	enough sait to fill the lower plen	num to the core plate. (GEH, INPO, Be	mis, KAPL).
	(b)(4),(b)(5)		
4556	ssment:		
		imped to the bottom of the core and fue	
		sed in salt and core flow is severely res	
		s are likely salted up restricting core sp er system is cooling the vessel but limi	
		er flow, if not blocked, should be fillin	
		height. There is likely no water level in	
		eved impeded by core damage. It is di	
	Siloud. Natural circulation being		
		the fuel Vergel term empty medines	un litrale motal
	how much cooling is getting to t	the fuel. Vessel temperature readings a anditions	ire likely metal
			ire likely metal
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[Task Tracker 4254] Page 5 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



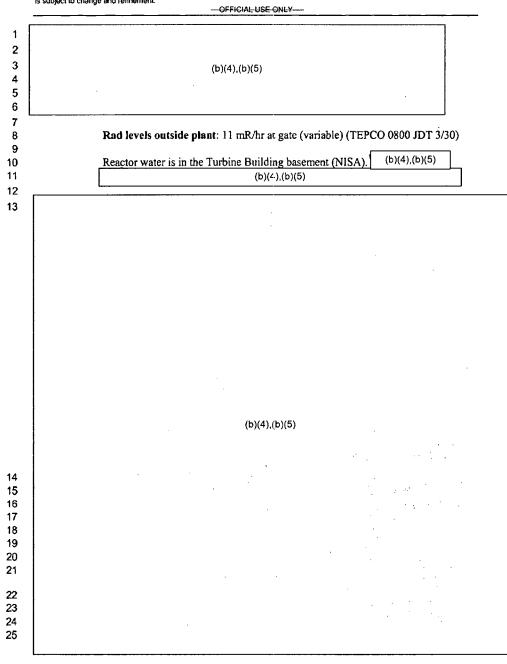
[Task Tracker 4254] Page 6 DRAFT - 1200 April 12, 2011 M:RSTJapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailchi

EY 653 of 942



[Task Tracker 4254] Page 7 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dalichi

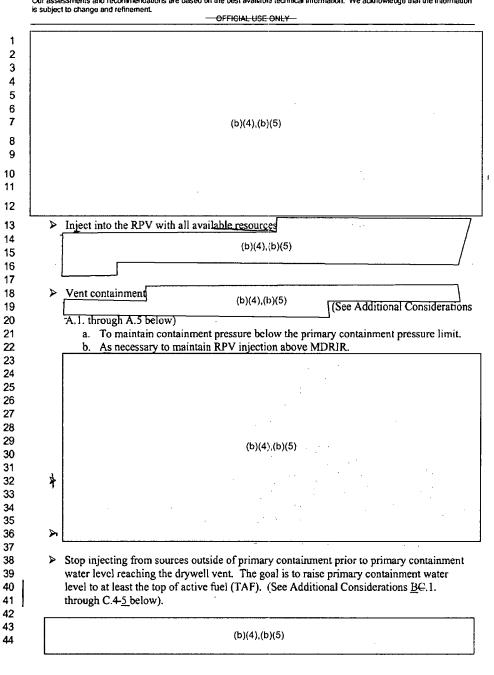
EY 654 of 942



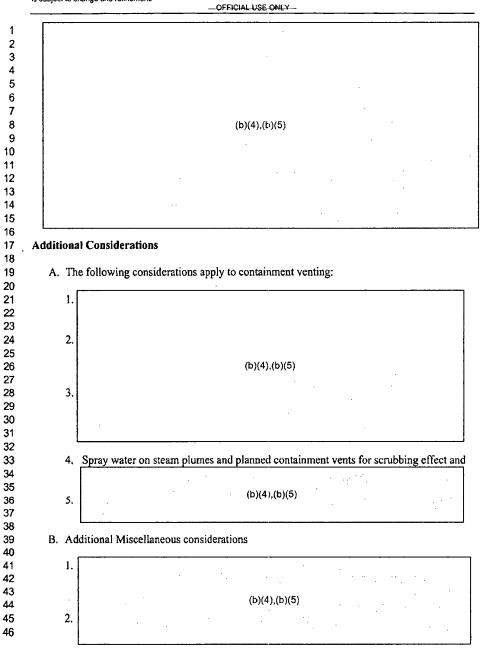
[Task Tracker 4254] Page 8 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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### EY 655 of 942



[Task Tracker 4254] Page 9 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailchi



[Task Tracker 4254] Page 10 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

#### EY 657 of 942

3.	Ensure spent fuel pool level is maintained as full as possible.
4.	
	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. Po	tential methods for monitoring containment level:
C. Po	÷.
C. Po 1.	(b)(4),(b)(5) HPC[(b)(4),(b)(5)]uction pressure and Drywell
	÷.
	(b)(4),(b)(5) HPC[(b)(4),(b)(5)] uction pressure and Drywell
1.	(b)(4),(b)(5) instrument taps
1. 2.	(b)(4),(b)(5) instrument taps Radiation monitoring instruments (b)(4),(b)(5)
1. 2. 3.	(b)(4),(b)(5) instrument taps
1. 2. 3.	(b)(4),(b)(5) instrument taps Radiation monitoring instruments (b)(4),(b)(5)

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 Page 11
 DRAFT - 1200 April 12, 2011

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I.

transfer from Reactor:	
	64 bundles (March 29 to April 2, 2010)
ay Heat [megawatt thermal (MV	Wth)]: 0.07 MWth (b)(6) evaporation rate 780 gallons per day
Pool Structural Support Integri	(b)(4),(b)(5)
Pool Leak Integrity:	No data
ality status:	No data
Pool Level:	No data
er Injection Method and Source	<ul> <li>Periodic fresh water injected via a hose off of a concrete pumper truck arm</li> </ul>
Pool Water Temperature:	18°C (3/31 0815)
er Status:	Electric power available; equipment testing in progress (JAIF, NISA, TEPCO)
r: <u>On March 12, 2011 a</u>	at 15:36 JT, a hydrogen explosion occurred during venting.
	(b)(4),(b)(5)
1 Assessment:	
	(b)(4),(b)(5)
1 SFP Recommendations:	
	·
	(b)(4),(b)(5)
:	
1 SFP Additional Consideration	1 <u>S:</u>
SFP Additional Consideration	<u>15:</u>

[Task Tracker 4254] Page 12 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 659 of 942

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LINET TWO			
	CORE		
ASSUMPTI	ONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)		
Control Para	ameter Assumptions: (As of 0700, 4/12/11)		
RPV Pressure	e (MPag)		
A – (023), s	teady (-3.3 psig)		
B – (-0.025),	steady (-3.6 psig)		
RPV Temper	ature (°C)		
Bottom Head	- 208.1, steady (406°F)		
Feedwater No	ozzle – 165.8 and lowering (330°F)		
PCV Pressure	e (MPaa)		
DW – 0.09 (1	3.1 psia)		
SC – unknow	'n		
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:			
<u>Other Inform</u>			
Other Infor	External AC power has reached the unit, checking integrity of equipment before		
<u>Other Infor</u> i			
<u>Other Infor</u>	External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4).(b)(5)		
<u>Other Infor</u>	External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4).(b)(5)		
<u>Other Infor</u>	External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5) (b)(4),(b)(5)		
<u>Other Infor</u>	External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5) (b)(4),(b)(5)		
<u>Other Infor</u>	External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5) (b)(4),(b)(5)		
<u>Other Infor</u>	External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5) (b)(4),(b)(5)		
<u>Other Infor</u>	External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5) (b)(4),(b)(5)		
<u>Other Infor</u>	External AC power has reached the unit, checking integrity of equipment before energizing. (b)(4),(b)(5) (b)(4),(b)(5)		
<u>Other Infor</u>	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)		
<u>Other Infor</u>	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)		

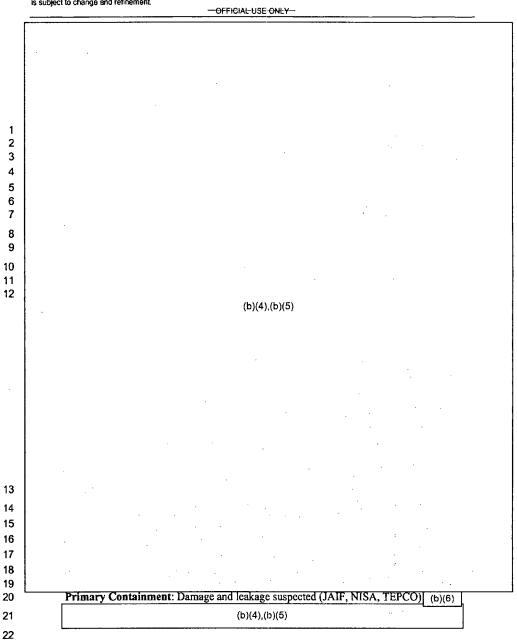
[Task Tracker 4254] Page 13 DRAFT - 1200 April 12, 2011 M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailchi

ł									
		(b)(4),(b)(5	)						
							(	 (b)(5)	<u> </u>
region of the core is lik less than U-1 based on			amount of sa	ilt build-up	appears to	be			
Injecting water through flow past the fuel. Wa 2/3 core height. While water level indication i	ter flow, if not blo core flow capabil s suspect due to er	Core flow ca core injection lin cked, should be f ity may be affect avironment. Nat	e is cooling filling the an ed due to co ural circulati	the vessel, nulus regio ntinued sal on believed	but with hi on of the ve t build up, d impeded	mited essel to RPV by			
Injecting water through flow past the fuel. Wa 2/3 core height. While water level indication is core damage. It is diff	ter flow, if not blo core flow capabil is suspect due to en icult to determine	Core flow ca core injection lin cked, should be f ity may be affect avironment. Nat how much coolir	te is cooling filling the an ed due to con ural circulati ng flow is get	the vessel, nulus regio ntinued sal on believed tting to the	but with hi on of the ve t build up, d impeded	mited essel to RPV by			
Injecting water through flow past the fuel. Wa 2/3 core height. While water level indication is core damage. It is diff	ter flow, if not blo core flow capabil is suspect due to en icult to determine	Core flow ca core injection lin cked, should be f ity may be affect avironment. Nat how much coolir	te is cooling filling the an ed due to con ural circulati ng flow is get	the vessel, nulus regio ntinued sal on believed tting to the	but with hi on of the ve t build up, d impeded	mited essel to RPV by			
Injecting water through flow past the fuel. Wa 2/3 core height. While water level indication is core damage. It is diff	ter flow, if not blo core flow capabil is suspect due to en icult to determine	Core flow ca core injection lin cked, should be f ity may be affect avironment. Nat how much coolir	te is cooling filling the an ed due to con ural circulati ng flow is get	the vessel, nulus regio ntinued sal on believed tting to the	but with hi on of the ve t build up, d impeded	mited essel to RPV by			
Injecting water through flow past the fuel. Wa 2/3 core height. While water level indication is core damage. It is diff	ter flow, if not blo core flow capabil is suspect due to en icult to determine	Core flow ca core injection lin cked, should be f ity may be affect nvironment. Nat how much coolin aperature which I	te is cooling filling the an ed due to con ural circulati ng flow is get	the vessel, nulus regio ntinued sal on believed tting to the	but with hi on of the ve t build up, d impeded	mited essel to RPV by			
salt build up. Injecting water through flow past the fuel. Wa 2/3 core height. While water level indication i core damage. It is diff temperature readings a	ter flow, if not blo core flow capabil is suspect due to en icult to determine	Core flow ca core injection lin cked, should be f ity may be affect nvironment. Nat how much coolin aperature which I	te is cooling filling the an ed due to con ural circulati ng flow is get	the vessel, nulus regio ntinued sal on believed tting to the	but with hi on of the ve t build up, d impeded	mited essel to RPV by			

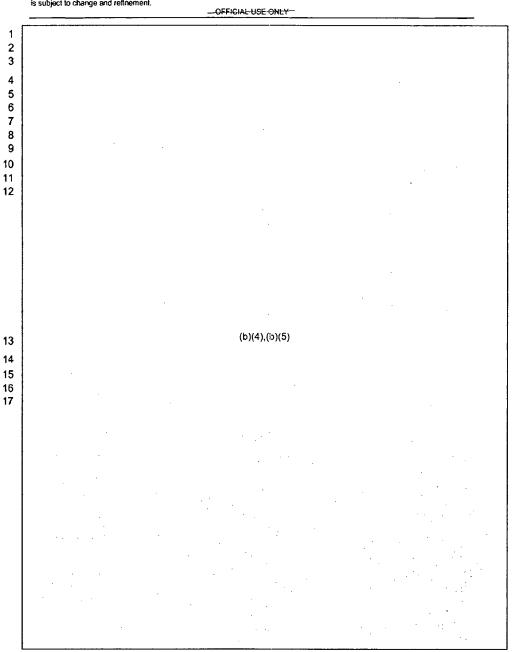
Our assessments and recommendations are based on the best available technical information. We acknowledge that the information

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[Task Tracker 4254] Page 14 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

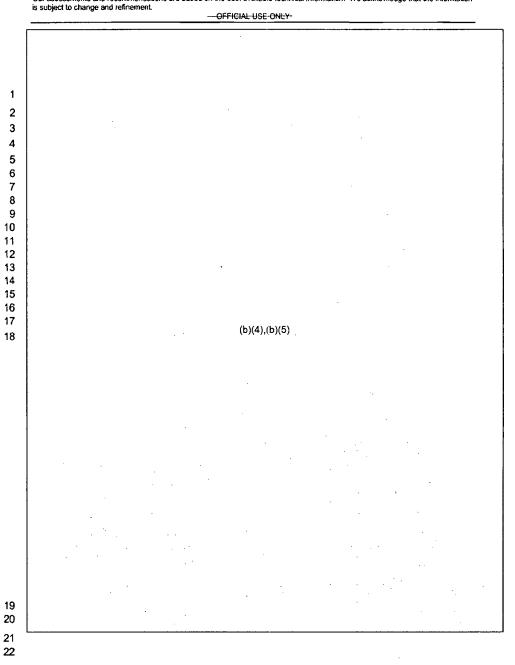


[Task Tracker 4254] Page 15 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



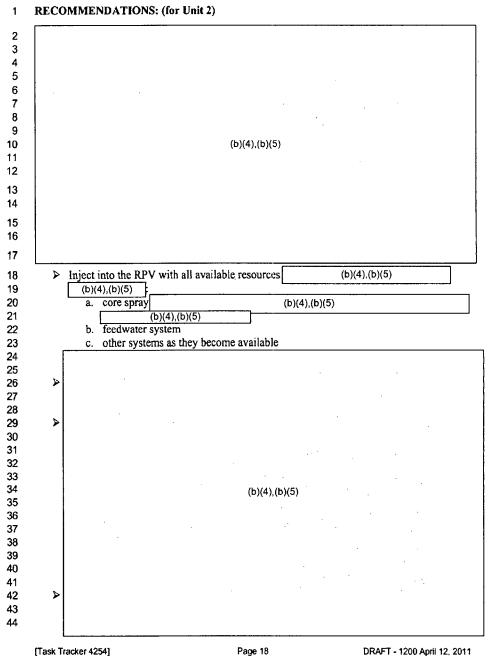
[Task Tracker 4254] Page 16 DRAFT - 1200 April 12, 2011 M:RSTJapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 663 of 942



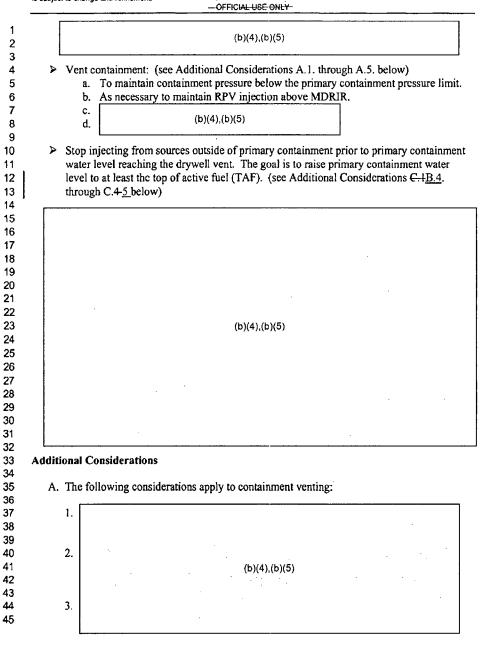
[Task Tracker 4254] Page 17 DRAFT - 1200 April 12, 2011 M:RSTVapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi

EY 664 of 942



[Task Tracker 4254] Page 18 DRA M:RSTUapanese Earthquake & Tsunami Responsei/RST Assessment of Fukushima Dailchi

EY 665 of 942



[Task Tracker 4254] Page 19 DRAFT - 1200 April 12, 2011 M:IRSTUapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Dailchi

EY 666 of 942

		(b)(4),(b)	0(5)		
	4. Spray wate	on steam plumes and planned	l containment vents for scrubbing effec	t.	
	5.	(b)(4	),(b)(5)		
B.	Additional Mis	cellaneous considerations			
	1. Borate wate	r if possible. It fuel pool level is maintained	as full as possible		
	3. Injection of		desired to provide cooling directly to th	е соте	
	4. When floor		implications of water weight on seismi	c	
<u>C.</u>	Potential method	ds for monitoring containmen (5)	t level. (b)(4),(b)(5)		
	€. ⊕.] (b	)(4),(b)(5) HPCI (b)(4	4),(b)(5 uction pressure and Drywell	•	Formatted: Indent: Left: 0.5", No bullets numbering
			- Ale Ale Judion pressure and Bry went		Formatted: Indent: Left: 0.5", Numbered
	instrument		· · · · · · · · · · · · · · · · · · ·		
	instrument b.2.Radiation r	taps. nonitoring instruments	(b)(4),(b)(5)		Level: 2 + Numbering Style: 1, 2, 3, + Si at: 1 + Alignment: Left + Aligned at: 0.75
	instrument b.2.Radiation r e.3	nonitoring instruments	·····		Level: 2 + Numbering Style: 1, 2, 3, + Si
	instrument b.2.Radiation r	nonitoring instruments	(b)(4),(b)(5) ),(b)(5)		Level: 2 + Numbering Style: 1, 2, 3, + Si at: 1 + Alignment: Left + Aligned at: 0.75

[Task Tracker 4254] Page 20 DRAFT - 1200 April 12, 2011 M:RSTJapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi

EY 667 of 942

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	Amount of fuel:	587 bundles				
	Last transfer from Reactor:	116 bundles (September 20-25, 2010)				
	Decay Heat [megawatt thermal (MW	th)]: 0.5 MWth; (b)(6) vaporation rate 5240 gallons pe day				
	Fuel Pool Structural Support Integrity	(b)(4),(b)(5)				
1	Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data Full [(b)(6) <mark>#/3)</mark>				
'	Water Injection Method and Source:					
	Fuel Pool Water Temperature:	46°C (TEPCO 4/12)				
	Other: External AC power ha	as reached the unit, checking the integrity of equipment (b)(4),(b)(5)				
	Unit 2 Assessment:					
	Unit 2 Assessment:	(b)(4),(b)(5)				
	Unit 2 Assessment: Unit 2 Recommendations:	(b)(4),(b)(5)				
		(b)(4),(b)(5) (b)(4),(b)(5)				

[Task Tracker 4254] Page 21 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

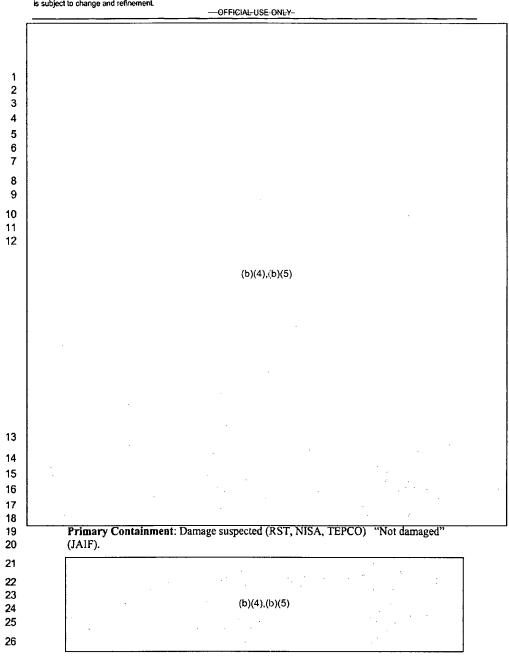
Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement. --- OFFICIAL-USE-ONLY-UNIT THREE CORE 3 ASSUMPTIONS: (based on input from multiple data sources: JAIF, NISA, TEPCO, & GEH) Control Parameter Assessment: (As of 0700, 4/12/11) RPV Pressure (MPag) A - (-.019), stcady (-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) 

[Task Tracker 4254] Page 22 DRAFT - 1200 April 12, 2011 M:RSTJapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi

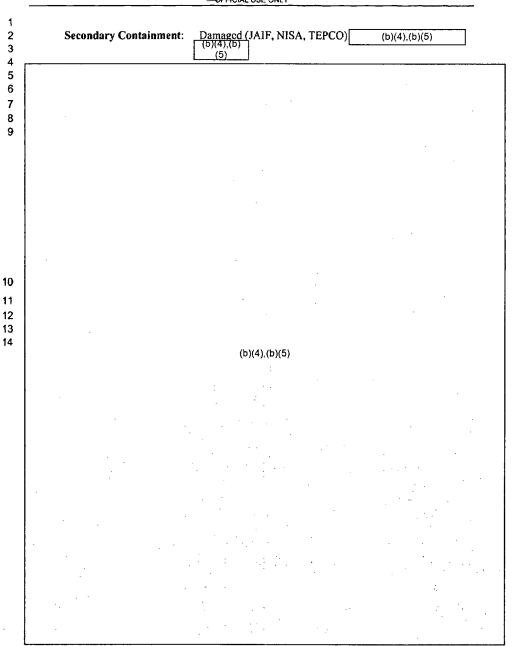
Core Status:	(b)(4),(b)(5)	)		
RPV Structural Inter (b)(4),(b)		<u> </u>		
Assessment:				
Damaged fuel may ha the core is likely enca	ve slumped to the bottom of the core sed in salt, however, the amount of si e reported lower temperatures. Core build up.	alt build-up appears to l	be less	
with limited flow past region of the vessel to continued salt build up	the RPV through the RHR system via the fuel. Water flow, if not blocked 2/3 core height. While core flow ca b, RPV water level indication is susp	, should be filling the an pability may be affected	nnulus d due to	
(6)(4) (6)(6)	b) Vessel temperature real	(b)(4).(b)(5) adings are likely metal		
(b)(4),(b)(5) temperature which lag	s actual conditions.	(b)(4),(b)(5)		(b)(5)
				<u>.</u>
	(b)(4),(b)(5)			(b)(5)
	(b)(4),(b)(5)			(b)(5) (b)(5)

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[Task Tracker 4254] Page 23 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

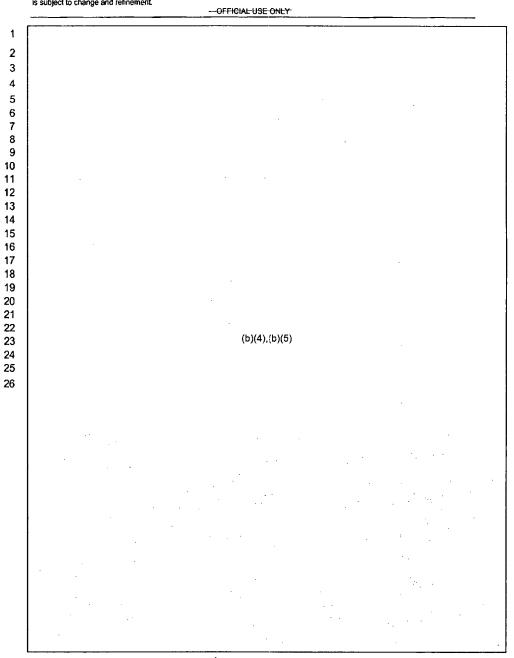


[Task Tracker 4254] Page 24 DRAFT - 1200 April 12, 2011 M:RSTUapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi



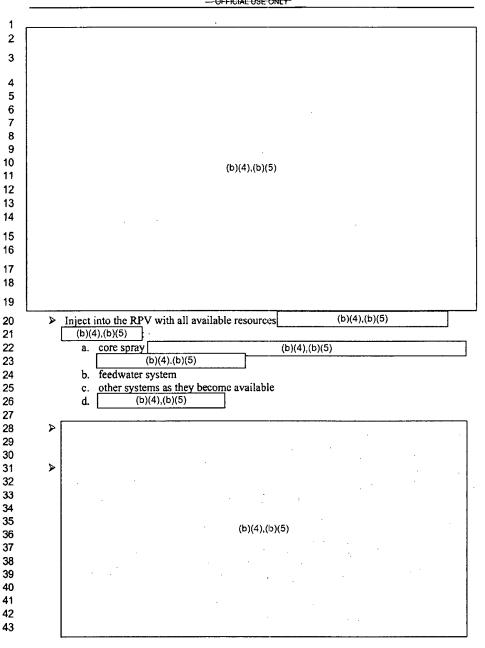
[Task Tracker 4254] Page 25 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dalichi

EY 672 of 942



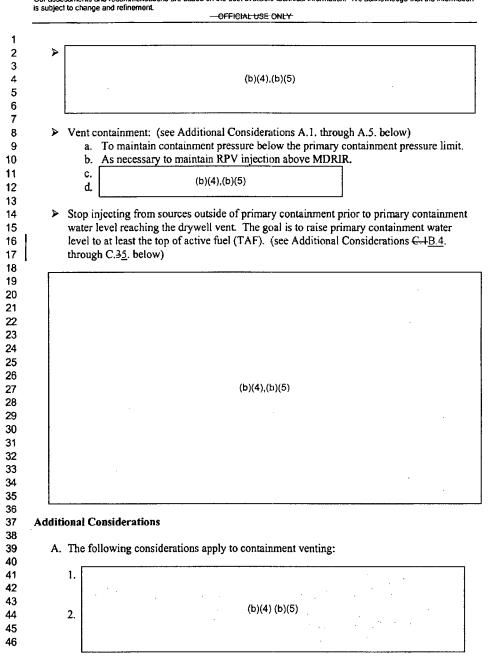
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[Task Tracker 4254] Page 26 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



[Task Tracker 4254] Page 27 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daliichi

# EY 674 of 942



Page 28 DRAFT - 1200 April 12, 2011 [Task Tracker 4254] M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

	OFFICIAL USE ONLY	
3	(b)(4),(b)(5)	
4	Spray water on steam plumes and planned containment vents for scrubbing effect.	
5	(b)(4),(b)(5)	
B. A	dditional Miscellaneous consideration	
1	(b)(4).(b)(5)	
3	Ensure spent fuel pool level is maintained as full as possible. 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.	
<u>C.</u> P	(b)(4),(b)(5)	
<del>C</del>		Formatted: Indent: Left: 0.5", No b numbering
	instrument taps 2.Radiation monitoring instruments (b)(4),(b)(5)	Formatted: Indent: Left: 0.5", Numl Level: 2 + Numbering Style: 1, 2, 3, at: 1 + Alignment: Left + Aligned at: Indent at: 1"
4	(b)(4),(b)(5)	

[Task Tracker 4254] Page 29 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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EY 676 of 942

	FFICIAL USE UNLY	
UNIT 3 - SPENT FUEL POOL STATUS		
Amount of fuel:	514 bundles	
Last transfer from Reactor:	148 bundles (June 23 to 28, <del>2011<u>2010</u>)</del>	
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per da	
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:	No data Full (b)(6) <b>///3</b> )	
Water Injection Method and Source:	Periodic fresh water injected via a hose off of a concrete pumper truck arm. 80 tons added on 4/	
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)	
- Unit 3 Additional Considerations:	(b)(4),(b)(5)	

[Task Tracker 4254] Page 30 DRAFT - 1200 April 12, 2011 M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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EY 677 of 942

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[Task Tracker 4254] Page 31 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

<del>.</del>	
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 energizing. (JAIF.	er has reached the <u>unit</u> , <u>checking electrical integrity of equipment before</u> NISA, TEPCO). (b)(4),(b)(5)
	(b)(4),(b)(5)
(b)(5)	

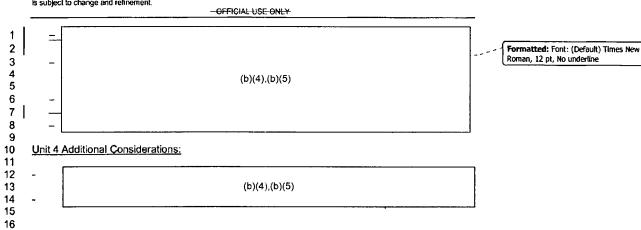
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[Task Tracker 4254] Page 32 DRAFT - 1200 April 12, 2011 M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailchi

EY 679 of 942

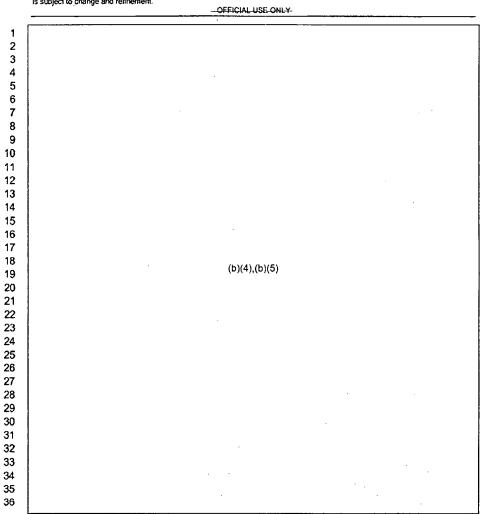
	-OFFICIAL-USE ONLY-	
UNIT 4 - SPENT FUEL POOL STAT	<u>us</u>	
Amount of fuel:	1331 bundles	
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)	
Decay Heat (MWth):	2.3 MWth (b)(6) evaporation rate 20,000 gallons per day	
Fuel Pool Structural Support Integrity	: Damage suspected (JAIF 3/28); (b)(4).(b)(5) (b)(4).(b)(5)	
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data 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 before energizing.	s reached the unit, checking electrical integrity of equipment	
Unit 4 Assessment:		
Unit 4 Assessment:	·	
Unit 4 Assessment:		
<u>Unit 4 Assessment:</u>	(b)(4),(b)(5)	
<u>Unit 4 Assessment:</u>	(b)(4).(b)(5)	Formatted: List Paragraph, Inde



[Task Tracker 4254] Page 34 DRAFT - 1200 April 12, 2011 M:RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dalichi

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EY 681 of 942



[Task Tracker 4254] Page 35 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

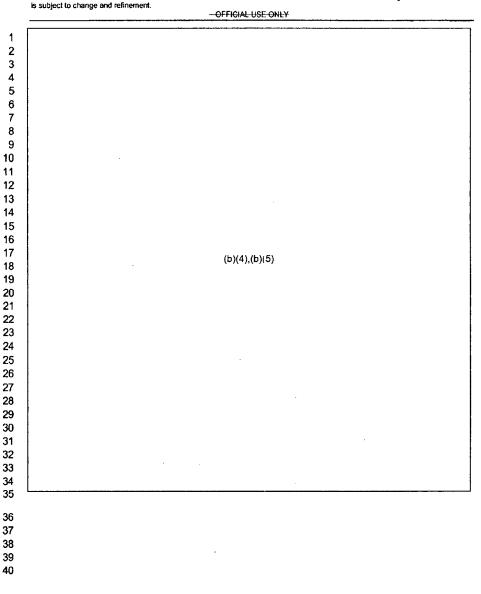
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UNIT FIVE	CORE	
ASSUMPT	IONS: (based on input from multiple data source:	JAIF, NISA, TEPCO, & GEH)
Core Status:	(b)(4),(b)(5)	In vesse
	(JAIF, NISA, TEPCO)	J
	RPV: pressure .4 psig↔ (NISA 4/8) ; Temp: 45	.5°C† (NISA 4/8);
Core Coolin	g: Functional (JAIF, NISA, TEPCO);	(b)(4),(b)(5)
	3/31);	· · · · · · · · · · · · · · · · · · ·
Primary Cor	tainment: Functional (JAIF, NISA, TEPCO)	
Secondary C		
Vent	hole drilled in rooftop to avoid hydrogen build up	(JAIF, NISA, TEPCO)
Spent Fuel F	Pool:	
946 1	oundles (b)(6) Temp: 34.7oC (JAIF 4/8)	(b)(4),(b)(5)
	ffsite AC power (b)(6) 3/28). External AC power	
	I generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5)	
diese	I generators available. Fuel Pool Cooling lost whe	
diese TEP	l generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5)	
diese TEP(	l generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT:	
diese TEP(	l generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5)	
diese TEP( 	l generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT:	
diese TEP( ASSESSME Unit five is f RECOMMI	I generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT: elatively stable. ENDATIONS:	
diese TEP( ASSESSME Unit five is f RECOMMI	l generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT: elatively stable.	
diese TEP( ASSESSME Unit five is f RECOMMI	I generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT: elatively stable. ENDATIONS:	
diese TEP( ASSESSME Unit five is + RECOMMI Repairs com	I generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT: elatively stable. ENDATIONS:	
diese TEP( ASSESSME Unit five is + RECOMMI Repairs com	I generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT: elatively stable. ENDATIONS:	
diese TEP( ASSESSME Unit five is + RECOMMI Repairs com	I generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT: elatively stable. ENDATIONS:	
diese TEP( ASSESSME Unit five is + RECOMMI Repairs com	I generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT: elatively stable. ENDATIONS:	
diese TEP( ASSESSME Unit five is + RECOMMI Repairs com	I generators available. Fuel Pool Cooling lost whe CO). (b)(4),(b)(5) (b)(4),(b)(5) CNT: elatively stable. ENDATIONS:	

[Task Tracker 4254] Page 36 DRAFT - 1200 April 12, 2011 M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

1	UNIT 5 - SP	ENT FUEL POOL STATUS			
23	Amount of fuel: Last transfer from Reactor: Decay Heat (MW):		946 bundles 120 bundles (January 8-13, 2011)		
4 5					
6 7   8			0.8 MW (b)(6)		
9 10	Fuel Pool St	ructural Support Integrity:	Not damaged (JAIF 4/4)		
11	Fuel Pool Le		No data		
12 13	Criticality sta Fuel Pool Le		No data Full		
14	ruerruo: Le	1401.			
15 16	Water Injection Method and Source:		Fuel pool cooling		
17 18	Fuel Pool Water Temperature:		37.9°C (JAIF 4/5)		
19 20 21 22	Other:		ing the unit, Unit 6 diesel generators available. Fuel mp failed (JAIF, NISA, and TEPCO). Repairs complete el pool cooling.		
23	Unit 5 Asses	sment:	,		
24 25	– Unit :	5 is stable with cooling capac	tity recovered.		
26 27 2 <b>8</b>	Unit 5 Recor	nmendations:			
29	-				
30	-		(b)(4),(b)(5)		
31 32	-				
33 34	Unit 5 Additi	onal Considerations:			
35	-				
36	-		(b)(4),(b)(5)		
37 38			· · · ·		
39					

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[Task Tracker 4254] Page 38 DRAFT - 1200 April 12, 2011 M:RSTUapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Dalichi

EY 685 of 942

•		-OFFICIAL-USE-ONLY-				
	UNIT SIX CORE					
	ASSUMPTIC	ONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)				
	Core Status:	(b)(4),(b)(5) In vesse				
		(JAIF, NISA, TEPCO)				
		RPV: pressure .7 psig $\leftrightarrow$ (NISA 4/8); Temp: 22.7°C $\leftrightarrow$ (NISA 4/8);				
	Core Cooling	: Functional (JAIF, NISA, TEPCO); Cooling using RHR; injection via normal make-up water (IAEA 3/31);				
	Primary Cont	ainment: Functional (JAIF, NISA, TEPCO)				
	Secondary Co	ontainment: Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)				
	Spent Fuel Pool:					
		876 bundles (b)(6) [remp: 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)				
	ASSESSME	NT:				
	Unit Six is <del>re</del> l	latively-stable.				
	RECOMME	NDATIONS:				
	1. Monit	OF				
	ABBREVIA	FIONS:				
		al Electric Hitachi ute of Nuclear Power Operations				
		Atomic Industrial Forum				
	NISA - Nucle	ear and Industrial Safety Agency				
1	TEPCO – Tol	kyo Electric Power Company				

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[Task Tracker 4254] Page 39 DRAFT - 1200 April 12, 2011 M:RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dalichi

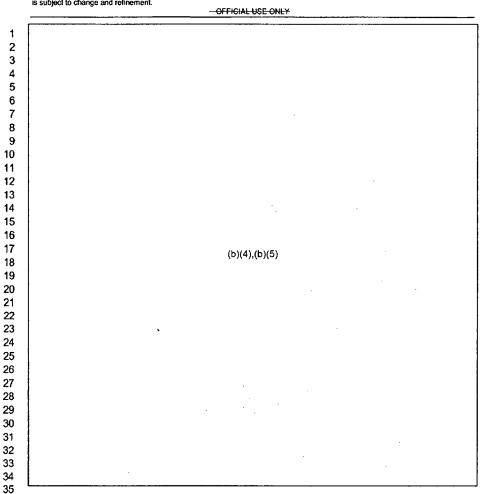
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	UNIT 6 - SPENT FUEL POOL STATUS			
	Amount of fuel:	876 bundles		
	Last transfer from Reactor:	184 bundles (August 10-25 2010)		
ł	Decay Heat (MW):	0.7 (MW) (b)(6)		
	Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)		
	Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data Full		
Water Injection Method and Source: Fuel Pool Water Temperature:		(b)(4),(b)(5) 28.5°C (TECPO 4/5)		
	Other: External AC power supplyi	ng the unit, Unit 6 diesel generators available. Fuel np failed (JAIF, NISA, and TEPCO). Repairs comp		
	Other: External AC power supplyi Pool Cooling lost when pur	ng the unit, Unit 6 diesel generators available. Fuel np failed (JAIF, NISA, and TEPCO). Repairs comp		
	Other: External AC power supplyi Pool Cooling lost when pur on RHR pump used for fue	ng the unit, Unit 6 diesel generators available. Fuel np failed (JAIF, NISA, and TEPCO). Repairs comp I pool cooling.		
	Other: External AC power supplyi Pool Cooling lost when pur on RHR pump used for fue Unit 6 Assessment:	ng the unit, Unit 6 diesel generators available. Fuel np failed (JAIF, NISA, and TEPCO). Repairs comp I pool cooling.		
	Other:       External AC power supplyin         Pool Cooling lost when purnon RHR pump used for fue         Unit 6 Assessment:         –       Unit 6 is stable with cooling capacity	ng the unit, Unit 6 diesel generators available. Fuel np failed (JAIF, NISA, and TEPCO). Repairs comp I pool cooling.		
	Other:       External AC power supplyin         Pool Cooling lost when purnon RHR pump used for fue         Unit 6 Assessment:         –       Unit 6 is stable with cooling capacity	ng the unit, Unit 6 diesel generators available. Fuel np failed (JAIF, NISA, and TEPCO). Repairs comp I pool cooling. ity recovered.		



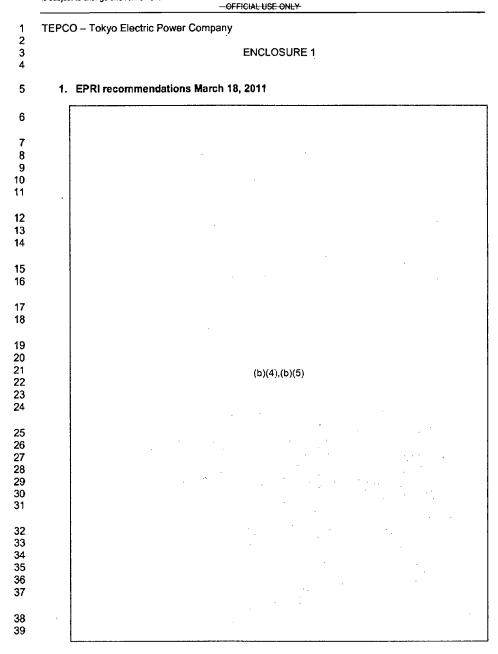
[Task Tracker 4254] Page 41 DRAFT - 1200 April 12, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dalichi

EY 688 of 942

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	Amount of fuel:	6375 bundles
	Last transfer from Reactor:	No data
•	Decay Heat (MW):	1.2 (MW) (b)(6)
€ ) 1	Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
2	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:	
2	Common SFP Assessment:	
	Relatively stable.	
5	Common SFP Recommendations:	
7	Common Or Pricecommendations.	
3	-	(b)(4) (b)(5)
)	-	(b)(4),(b)(5)
)		
1 2	Common Additional Considerations:	
3	Common Additional Considerations.	
	_	
	-	(b)(4),(b)(5)
	REFERENCES	
	REFERENCES	20044
; ; ; ; ; ;	1. EPRI recommendations March 18	
4 5 7 8 9	EPRI recommendations March 18     SFP Criticality Potential, Kent Wo	od, March <u>2</u> 4, 2011
↓ 5 7 3 9	1. EPRI recommendations March 18	od, March <u>2</u> 4, 2011
; ; ; ; ;	<ol> <li>EPRI recommendations March 18</li> <li>SFP Criticality Potential, Kent Wo</li> <li>Spent Fuel Inventories Document</li> </ol>	od, March <u>2</u> 4, 2011
	EPRI recommendations March 18     SFP Criticality Potential, Kent Wo	od, March <u>2</u> 4, 2011
	<ol> <li>EPRI recommendations March 18</li> <li>SFP Criticality Potential, Kent Wo</li> <li>Spent Fuel Inventories Document</li> </ol>	od, March <u>2</u> 4, 2011
	EPRI recommendations March 18     SFP Criticality Potential, Kent Wo     Spent Fuel Inventories Document <u>ABBREVIATIONS:</u>	od, March <u>2</u> 4, 2011
; ; ; ; ;	EPRI recommendations March 18     SFP Criticality Potential, Kent Wo     Spent Fuel Inventories Document <u>ABBREVIATIONS:</u> GEH – General Electric Hitachi	od, March <u>2</u> 4, 2011

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[Task Tracker 4254] Page 43 DRAFT - 1200 April 12, 2011 M:NSTUapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi

EY 690 of 942

# EY 691 of 942

[Task Tracker 4254] Page 44 DRAFT - 1200 April 12, 2011 M:RST Japanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi


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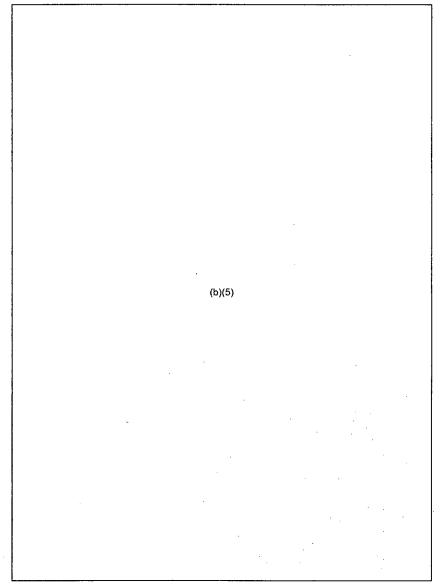
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Our assessments and recommendations are based on the best available technical information. We acknowledge that the information is subject to change and refinement.

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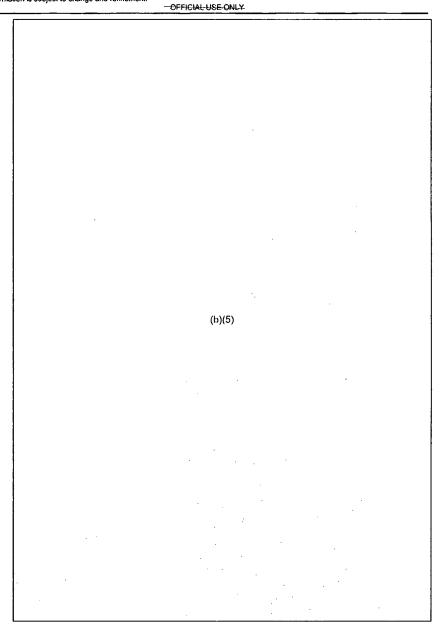
#### ENCLSOURE 2





[Task Tracker 4254] Page 45 DRAFT - 1200 April 12, 2011 M:\RSTUapanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailchi

# EY 692 of 942



[Task Tracker 4254] Page 46 DRAFT - 1200 April 12, 2011 M/RSTUapanese Earthquake & Tsunami Response/RST Assessment of Fukushima Daiichi

#### -<del>Official Use Only</del> 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

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.

#### ENCLOSURE 3

#### Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

	React	or Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(b)(d)	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
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.

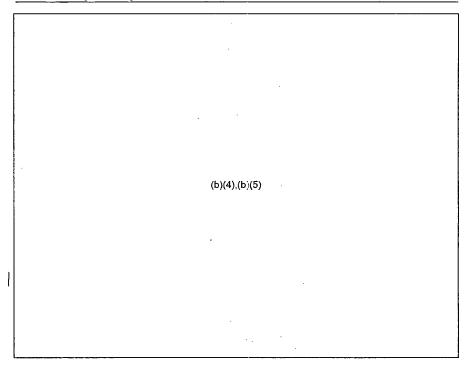
	(b)(4),(b)(5)		

Page 47

#### -Official Use Only-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

#### 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.

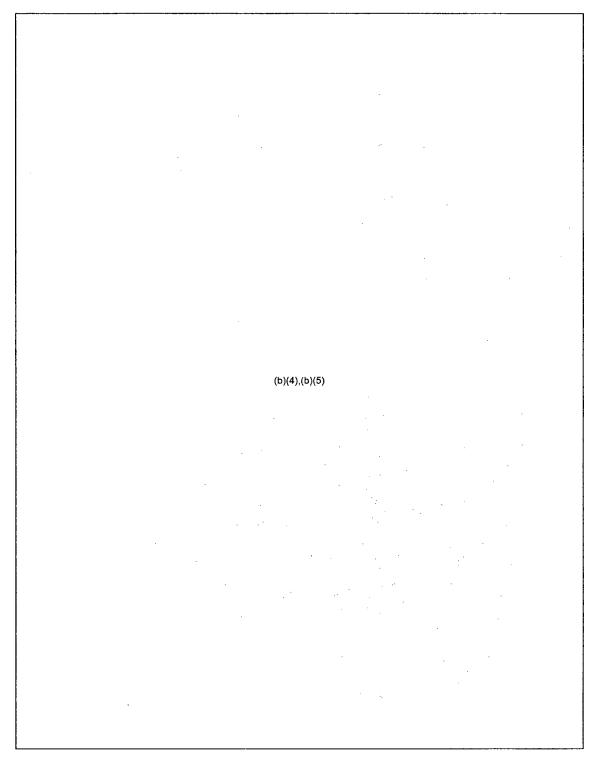


Page 48

# EY 695 of 942

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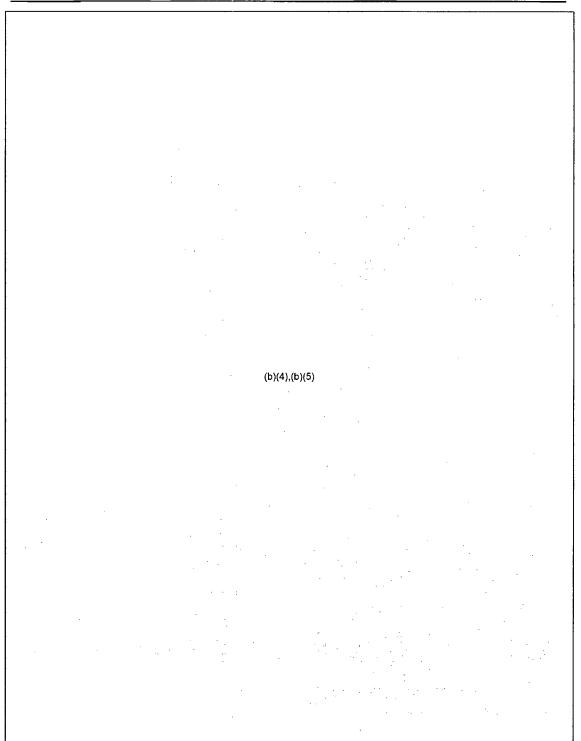
#### RST ASSESSMENT OF FUKUSHIMA DAHCHI UNITS (REV 2), Based on most recent available data and input from GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE



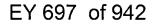
[Task Tracker 4254] Page 1 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



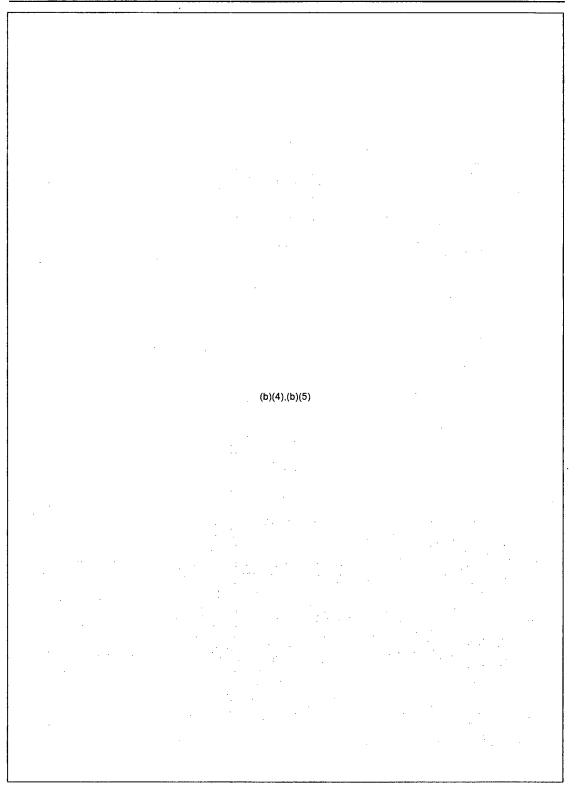
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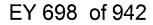
[Task Tracker 4254] Page 2 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

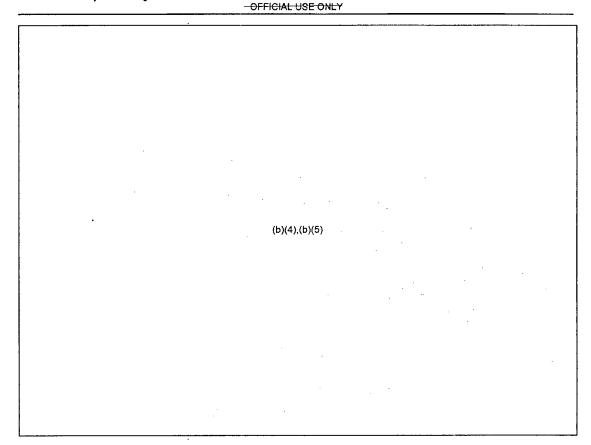


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[Task Tracker 4254] Page 3 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



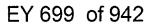


## Definitions

<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.



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## 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 abo	ve 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,		<u>,</u>	7
	(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)

[Task Tracker 4254] Page 5 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

External AC power to the Main Control Room of U-1 becan JDT 3/24/2011. Lighting in Main Control Room is operatin (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.

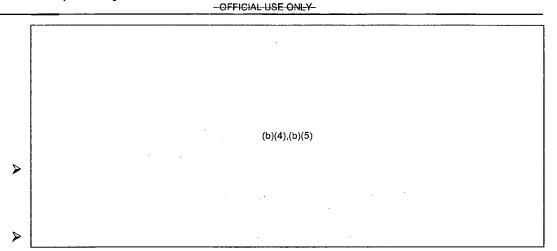
The primary containment is not damaged.

**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)		•
	<b>T</b>			
	Vent containment	(b)(4),(b)		. 1
	(b)(4),(b)		(See Addi	tional
	Considerations A.1. through A.:	5 below)		
	a. To maintain containmen	t pressure below the pr	imary containn	nent pressure limi
	b. As necessary to maintain			•
	c.			
	d.	(b)(4),(b)(5)		
	u.			

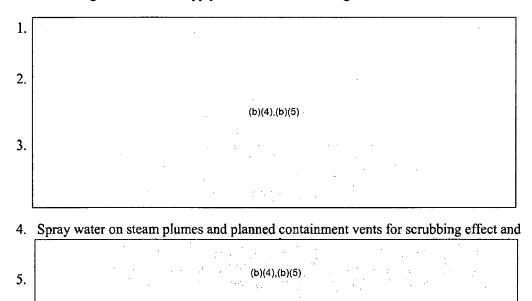
[Task Tracker 4254] Page 6 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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:



## B. Additional Miscellaneous considerations

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

[Task Tracker 4254] Page 7 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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2.	(b)(4),(b)(5)	
3.	Ensure spent fuel pool level is maintained as full as possible.	]

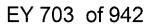
4. Injection of water via the CRD system is desired to provide cooling directly to the core and for cooling material on bottom of vessel. (b)(4).(b)(5)

(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)	CI (b)(4),(b)(5) suction pressure and Drywell
	instrument taps	· · · · · · · · · · · · · · · · · · ·
2.	Radiation monitoring instruments	(b)(4).(b)(5)
3.		
4.		(h)(4) (h)(5)
		(b)(4),(b)(5)
5.		



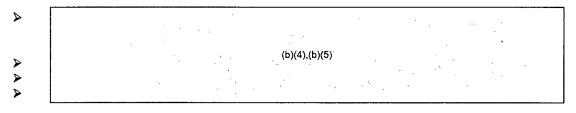
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UNIT 1 - SPENT FUEL POOL STATUS (1	400 April 6 <sup>th</sup> )	
Amount of fuel:	292 bundles	
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)	
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day	
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)	
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data 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:

|--|

## Unit 1 Recommendations:



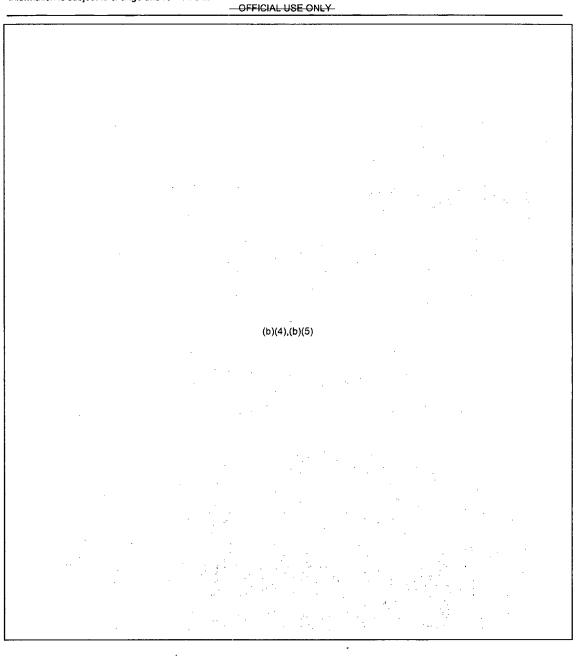
#### Unit 1 Additional Considerations:

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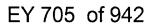
-	· · ·				
	(b)(	4),(b)(5)		÷ .	
-	· ·				

[Task Tracker 4254] Page 9 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailichi

EY 704 of 942



[Task Tracker 4254] Page 10 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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## 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 $\downarrow$  (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:

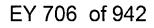
	(b)(4),(b)(5)					
. · · ·	(b)(4),(b)(5)		May begin to inject			
nitrogen ges (NIHK World News)						

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)



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#### 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.

۶	Inject	into the RP	V with all availa	ble resources (b)(4),(b)(5)
	(b)(	(4).(b)(5)		
	а.	core spray		(b)(4),(b)(5)
			(b)(4).(b)(5)	
	b.	feedwater	system	
	с.	other syste	ems as they beco	me available
AA		•		(b)(4),(b)(5)

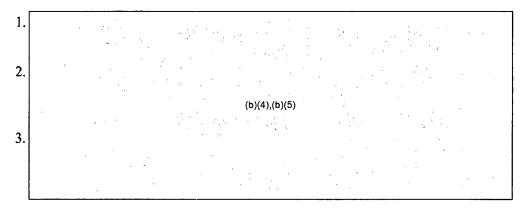
[Task Tracker 4254] Page 12 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

: 	
	(b)(4),(b)(5)
4	
-	
	L

- > 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)
- 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:



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

[Task Tracker 4254] Page 13 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailichi

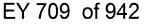
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5. (b)(4),(b)(5)

- 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

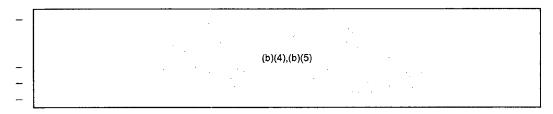
	(b)(4),(b)(5)	
а.	(b)(4),(b)(5)	PCI (b)(4),(b)(5) suction pressure and Drywell
	instrument taps	
b.	Radiation monitoring instruments	(b)(4).(b)(5)
	· · ·	
с.		
d.		(b)(4),(b)(5)
e.		
		······································



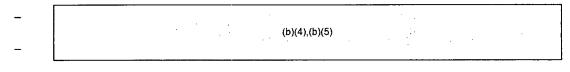
·····	· · · · · · · · · · · · · · · · · · ·				
UNIT 2 - SPENT FUEL POOL STATUS					
Amount of fue	el:	587 bundles			
Last transfer from Reactor:		116 bundles (September 20-25, 2010)			
Decay Heat [megawatt thermal (MWth)]:		0.47 MWth; evaporation rate 5240 gallons per day			
Fuel Pool Stru	uctural Support Integrity:	(b)(4),(b)(5)			
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:		No data No data 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 Wa	ter Temperature:	71°C (TEPCO 4/5)			
Other: External AC power has reach before energizing.		hed the unit, checking the integrity of equipment (b)(4),(b)(5)			
Unit 2 Assess	ment:				
<b>-</b>					

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

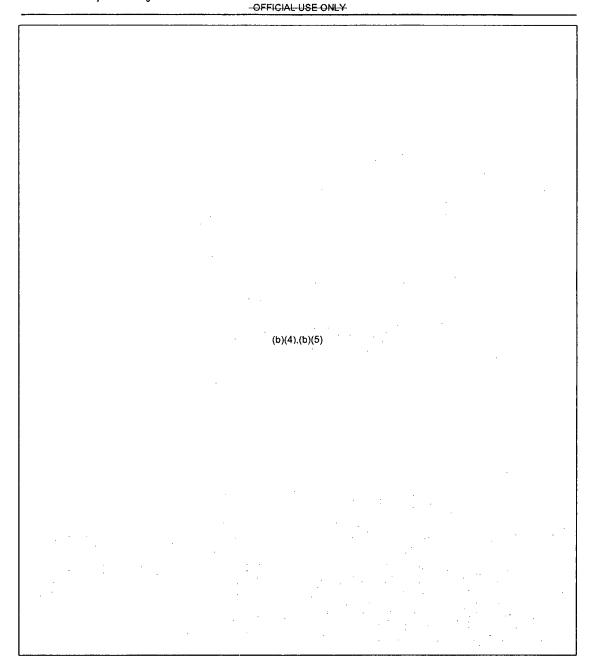
## Unit 2 Recommendations:



### Unit 2 Additional Considerations:



EY 710 of 942



[Task Tracker 4254] Page 16 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 711 of 942

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## 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 psig1, ch B= -11.4 psig)  $\leftrightarrow$  (NISA 4/8); RPV temp: Btm Head 110.8°C $\leftrightarrow$ ; FW nozzle: 88.8°C $\leftrightarrow$  (NISA 4/8)

Core Cooling: Freshwater injection 30.8 gpm  $\leftrightarrow$  (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<sub>2</sub> explosion. May begin to inject nitrogen gas (NHK World News)

Spent Fuel Pool

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

Rad Levels: DW 1880 rem/hr  $\leftrightarrow$  (NISA 4/8), torus 73.8 rem/hr  $\leftrightarrow$  (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)		

[Task Tracker 4254] Page 17 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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### 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.



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## **RECOMMENDATIONS:**

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

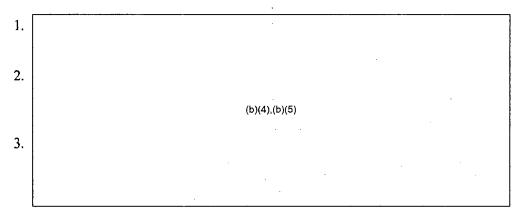
$\triangleright$			V with all available :	resources	(b)(4),(b)(5)	
		(4),(b)(5)				
	а.	core spray		(b)(4),(b	)(5)	
	_		(b)(4),(b)(5)			
		feedwater	system			
	¢.	other syste	ems as they become	available		
			* :			
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				(b)(4),(b)(5)		
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- > 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)

 [Task Tracker 4254]
 Page 19
 DRAFT - 0600 April 11, 2011

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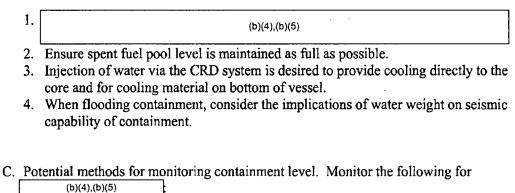
## Additional Considerations



A. The following considerations apply to containment venting:

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

B. Additional Miscellaneous consideration



a.	(b)(4),(b)(5) HP	CI (b)(4),(b)(5) suction pressure and Dryw
	instrument taps	
b.	Radiation monitoring instruments	(b)(4),(b)(5)
c.		
d.		b)(4),(b)(5)

[Task Tracker 4254] Page 20 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

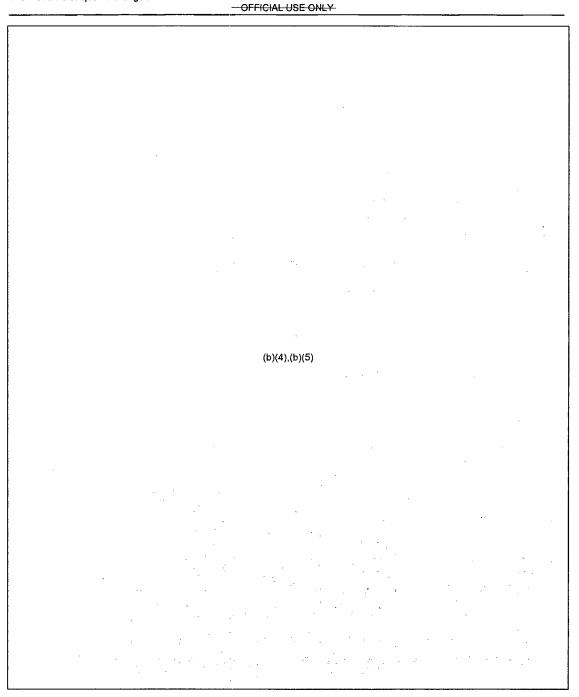
UNIT 3 - SPENT FUEL POOL STATUS			
Amount of fuel:	514 bundles		
Last transfer from Reactor:	148 bundles (June 23 to 28, 2011)		
Decay Heat (MWth):	0.23 MWth; evaporation rate 2570 gallons per day		
Fuel Pool Structural Support Integrity:	Damage suspected (JAIF 3/28); (b)(4),(b)(5) (b)(4),(b)(5)		
Fuel Pool Leak Integrity: Criticality status: Fuel Pool Level:	No data No data 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)			
-		· · · · · · · · · · · · · · · · · · ·	·	•	



[Task Tracker 4254] Page 22 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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### 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.

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## **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 Lea Criticality statu Fuel Pool Lev	is:	No data No data Low water level (b)(6) \$/1)		
Water Injectio	n 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 Wat	ter Temperature:	30°C (JAIF 4/4)		
Other:	External AC power has reached the unit, checking electrical integrity of equipment before energizing.			

## Unit 4 Assessment:

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

## Unit 4 Recommendations:

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			· ·
		(b)(4),(b)(5)	
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## Unit 4 Additional Considerations:

[Task Tracker 4254] Page 24 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

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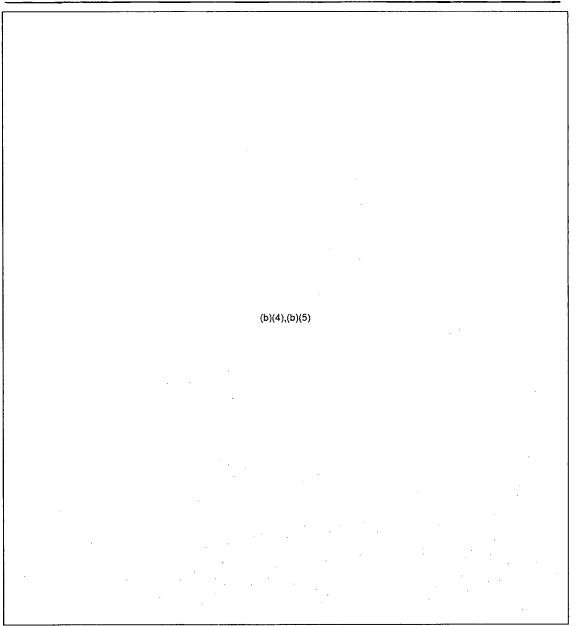
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(b)(4),(b)(5)

[Task Tracker 4254] Page 25 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailchi

EY 720 of 942

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 [Task Tracker 4254]
 Page 26
 DRAFT - 0600 April 11, 2011

 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 721 of 942

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# UNIT FIVE CORE

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

Core St	tatus:	(b)(4).(b)(5)	In vessel	
		(JAIF, NISA, TEPCO)	L	
		RPV: pressure .4 psig $\leftrightarrow$ (NISA 4/8) ; Temp: 45.5°C $\uparrow$ (NISA 4/8);		
Core C	ooling:	: Functional (JAIF, NISA, TEPCO); (b)(4).(b)(5) 3/31);		
Primar	y Conta	ainment: Functional (JAIF, NISA, TEPCO)		
Second		ontainment: nole drilled in rooftop to avoid hydrogen build up (JAIF, NISA, TEPCO)		
Spent I		ool: undles (JAIF); Temp: 34.7oC↓ (JAIF 4/8); Cooling capability recovered (	JAIF 4/1)	
	diesel	fsite AC power (IAEA 3/28). External AC power supplying the unit, Unit generators available. Fuel Pool Cooling lost when pump failed (JAIF, NI		
	TEPCO	O). (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

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# **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: Criticality status:	No data No data
Criticality status:	No data

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:

-	,		
	1.	(b)(4),(b)(5)	
			·

-OFFICIAL USE ONLY (b)(4),(b)(5)

[Task Tracker 4254] Page 29 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 724 of 942

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# 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 $\leftrightarrow$ (NISA 4/8); Temp: 22.7°C $\leftrightarrow$ (NISA 4	/8);
Core Cooling	g: Functional (JAIF, NISA, TEPCO); (b)(4),(b)(5)	
Primary Cont	tainment: Functional (JAIF, NISA, TEPCO)	
Secondary Co	ontainment: Vent hole drilled in rooftop to avoid hydrogen build up (JAIF, N	
	vent hole armed in tookop to avoid hydrogen band up (5Am, 14	юл, ты сој
Spent Fuel Po		4),(b)(5)
Other:	On offsite AC power (b)(4).(b)(5)	

**ASSESSMENT:** 

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

Unit Six is relatively stable. RECOMMENDATIONS:

# 1 14 1.

1. Monitor

# **ABBREVIATIONS:**

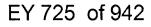
GEH – General Electric Hitachi

INPO - Institute of Nuclear Power Operations

JAIF – Japan Atomic Industrial Forum

NISA – Nuclear and Industrial Safety Agency

TEPCO – Tokyo Electric Power Company



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# **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: Criticality status: Fuel Pool Level:	No data No data Fuli
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:

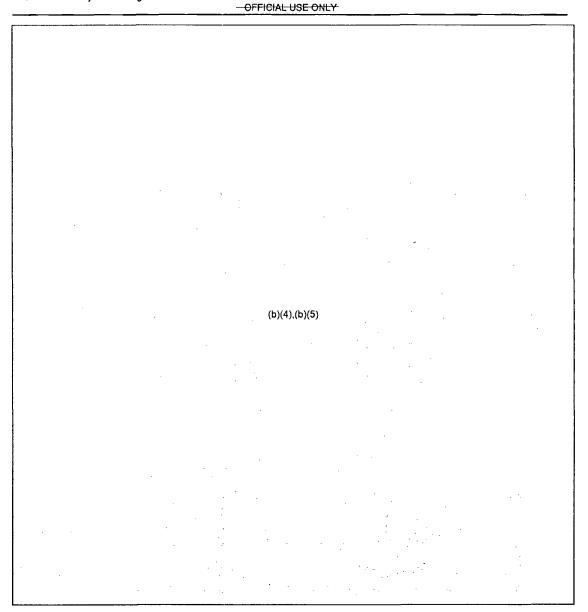
- Unit 6 is stable with cooling capacity recovered.

Unit 6 Recommendations:

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

Unit 6 Additional Considerations:

	 	· ·	
· .	 (b)(4),(b)(5)		



[Task Tracker 4254] Page 32 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Dailchi

EY 727 of 942

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# **COMMON - SPENT FUEL POOL STATUS**

Amount	of fuel:	6375 bundles	
Last tran	sfer from Reactor:	No data	
Decay H	leat (MW):	1.2 (MW) (b)(6)	
Fuel Poo	ol Structural Support İntegrity:	Not damaged (JAIF 4/4)	
Fuel Poo Criticality Fuel Poo		No data No data Full	
Water In	jection Method and Source:	(b)(4),(b)(5)	
Fuel Pool Water Temperature:		28.0°C (TECPO 4/5)	
Other:			
Commor	SFP Assessment:		
Relativel	ly stable.		
<u>Commor</u>	n 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

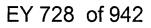
### ABBREVIATIONS:

GEH – General Electric Hitachi

INPO - Institute of Nuclear Power Operations

- JAIF Japan Atomic Industrial Forum
- NISA Nuclear and Industrial Safety Agency

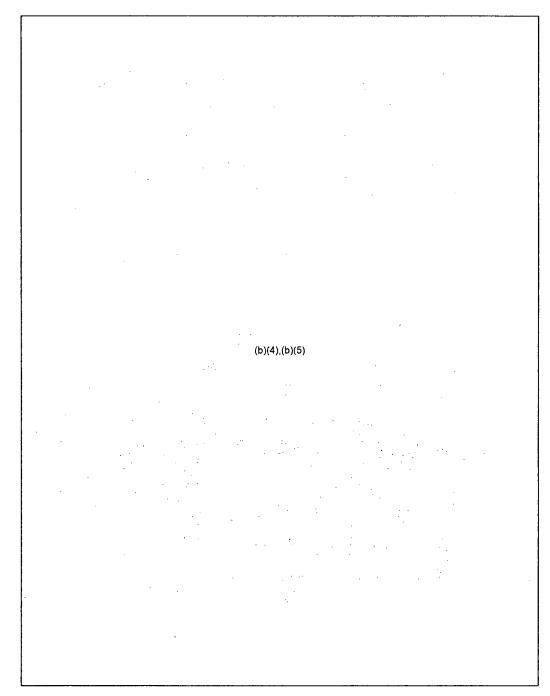
[Task Tracker 4254] Page 33 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi



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TEPCO - Tokyo Electric Power Company

# **ENCLOSURE 1**



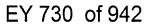
# 1. EPRI recommendations March 18, 2011

[Task Tracker 4254] Page 34 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 729 of 942

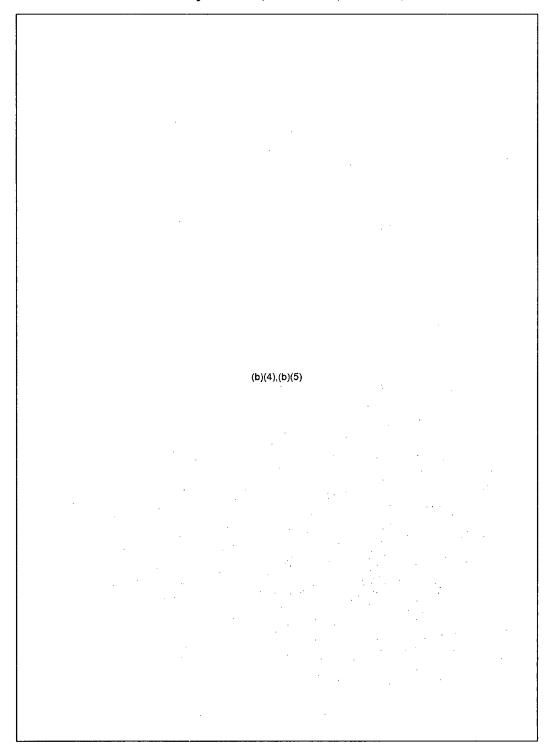
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(b)(4),(b)(5)



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# **ENCLSOURE 2**

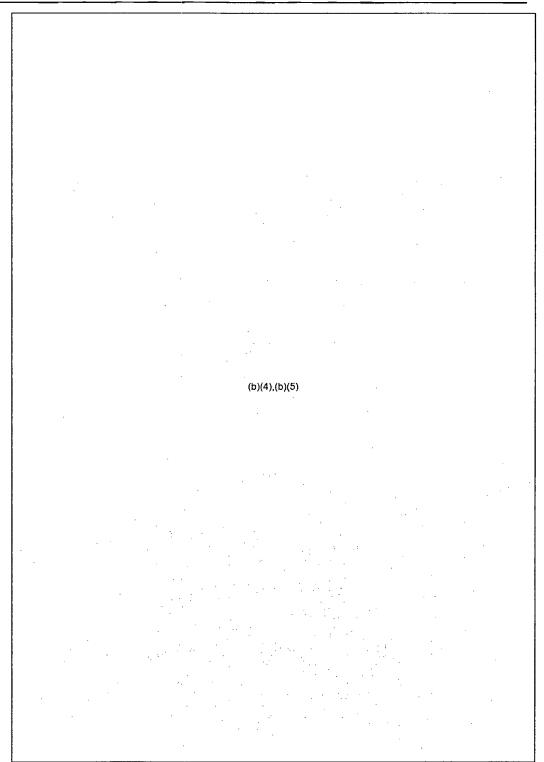


SFP Criticality Potential, Kent Wood, March 24, 2011

[Task Tracker 4254]Page 36DRAFT - 0600 April 11, 2011M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 731 of 942

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[Task Tracker 4254] Page 37 DRAFT - 0600 April 11, 2011 M:\RST\Japanese Earthquake & Tsunami Response\RST Assessment of Fukushima Daiichi

EY 732 of 942

### Official Use Only—— 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

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.

# **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

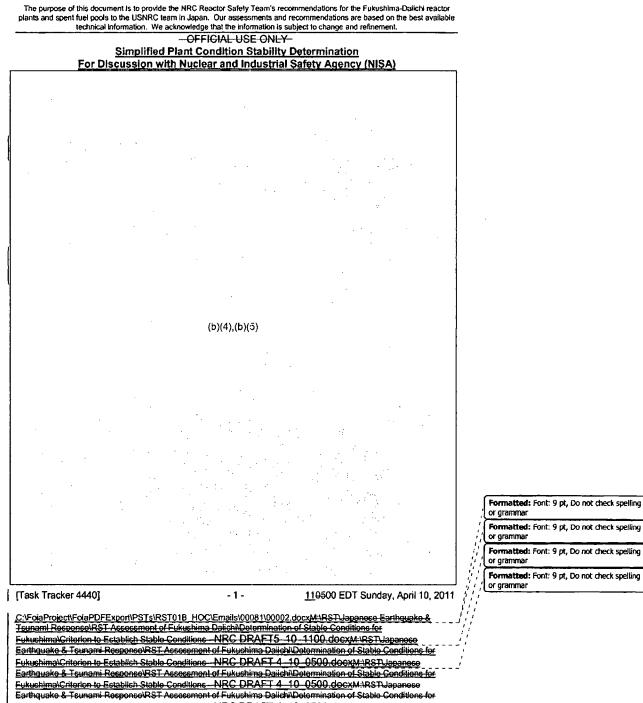
Fuel assembly type and burn-up

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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EY 735 of 942

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<u>11</u>9500 EDT Sunday, April 10, 2011

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The purpose of this document is to provide the NRC Reactor Safety Team's recommendations for the Fukushima-Dailchi 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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EY 736 of 942

The purpose of this document is to provide the NRC Reactor Safety Team's recommendations for the Fukushima-Daiich 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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[Task Tracker 4440]

- 4 -

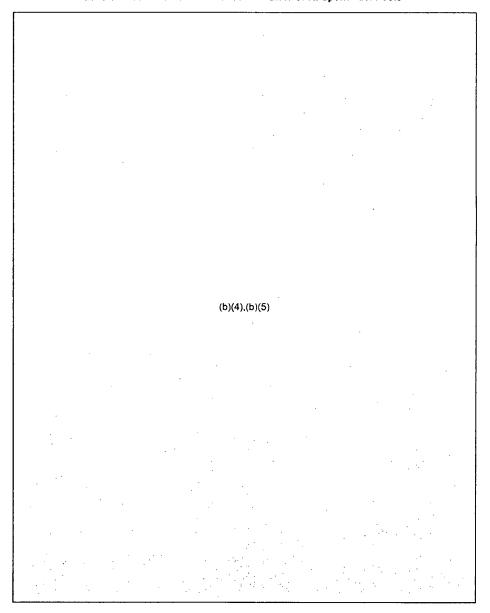
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EY 737 of 942

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.





Page 1

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Dailchi 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)	

# SPENT FUEL POOL STATUS (2100 April 4th)

Fukushima Dailchi 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:	10°C (3/31 0815)	(b)(5)	
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)

Page 2

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 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	n)]: 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:		1	
	(b)(4),(b)(5)		

Page 3

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 2 Recommendations:

	(1	o)(4),(b)(5)		

Unit 2 Additional Considerations:

-	(b)(4),(b)(5)		
Fukushima Daiichi Unit 3			
Amount of fuel:	514 bundles		
Last transfer from Reactor:	<sup>148</sup> 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 (JAIE 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:	Source: Periodic fresh water injected via concrete bumper (b)(5)		
Fuel Pool Water Temperature:	56°C (JAIF 4/5)		
Other:			
Unit 3 Assessment:			
	(b)(4),(b)(5)		

Page 4

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Datichi 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 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) /1)
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper (b)(5)
Fuel Pool Water Temperature:	42°C (JAIF 4/3)
Other: External AC power has re before energizing.	ached the unit, checking electrical integrity of equipment
Unit 4 Assessment:	



Page 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.

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#### Unit 4 Recommendations:

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

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# Unit 4 Additional Considerations:

-		(b)(4),(b)(5)		
Eukushima I	Daiichi Unit <u>5</u>			
Amount of fu	lei:	946 bundles		
Last transfe	r from Reactor:	120 bundles (January 8-13, 2011)		
Decay Heat	(MW):	0.8 MW (b)(6)		
Fuel Pool St	ructural Support Integrity:	Not damaged (JAIF 4/4)		
Fuel Pool Le	eak 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 Asses	ssment			
Stable.				
Unit 5 Reco	mmendations:			

Page 6

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The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Daüchi 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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Unit 5 Additio	onal Considerations:				
-	(b)(4),(b)(5)				
Fukushima D	Daiichi Unit 6				
Amount of fu	<del>o</del> l:	876 bundles			
Last transfer	from Reactor:	184 bundles (August 10-25 2010)			
Decay Heat	(MW):	0.7 (MW) (b)(6)			
Fuel Pool Str	ructural Support Integrity:	Not damaged (JAIF 4/4)			
Fuel Pool Le	ak Integrity:	No data			
Criticality sta	tus:	No data			
Area Radiatio	on Levels:	No data			
Fuel Pool Level:		Full			
Water Injection Method and Source:		(b)(4),(b)(5)			
Fuel Pool Wa	ater Temperature:	28.5°C (Steady) (TECPO 4/5)	Comr	(b)(5)	
Other:		the unit, Unit 6 diesel generators available. Fuel Pool d (JAIF, NISA, TEPCO). Repairs complete on RHR ing.			_
Unit 6 Asses	sment:				
Relatively sta	ible.				
Unit 6 Recon	nmendations:				
-	······	(b)(4) (b)(5)			
Unit 6 Additic	onal Considerations:		_		
-	(b)(4),(b)(5)				
		Page 7 0400 Tuesday, April 05, 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)		
Fukushima Daijchi 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

Page 8

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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### 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.

Page 9

0400 Tuesday, April 05, 2011

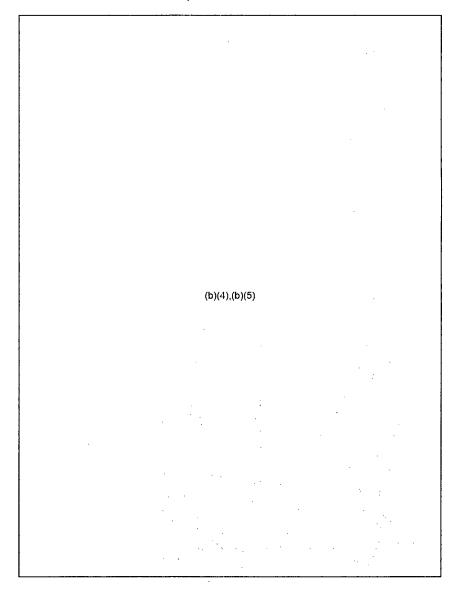
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EY 746 of 942

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the FukushIma-Datichi 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.

#### ENCLOSURE 1

1. EPRI recommendations March 18, 2011



Page 10

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

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

Page 11

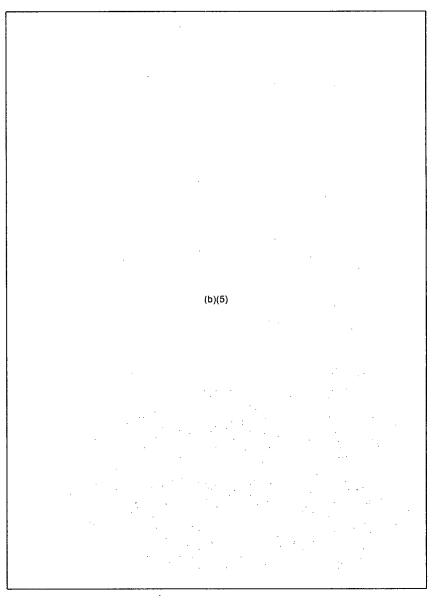
0400 Tuesday, April 05, 2011

# EY 748 of 942

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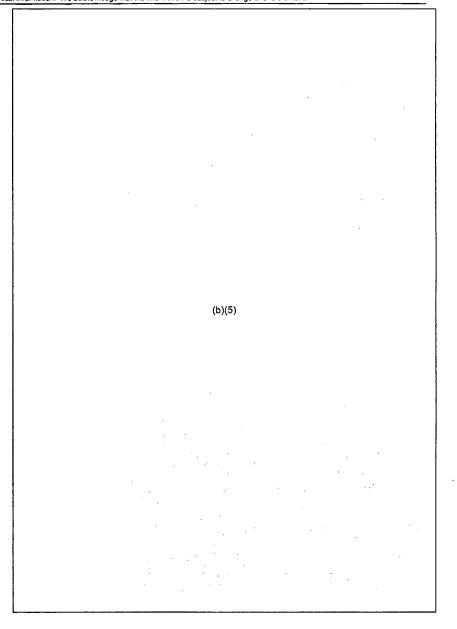
The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Datichi Spent Fuel Pools to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical information. We acknowledge that the information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

# ENCLSOURE 2



SFP Criticality Potential, Kent Wood, March 4, 2011

Page 12



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Page 13

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0400 Tuesday, April 05, 2011

EY 750 of 942

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The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Datichi Speni 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.

#### 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	 (5)(4)	1, 331
Unit 5	 (b)(4)	946
Unit 6		876
Shared pool		6, 375
total		10, 921

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Fuel assembly type and burn-up

See attachment 1.

The most recent transfers of fuel from reactor cores to their spent fuel pool

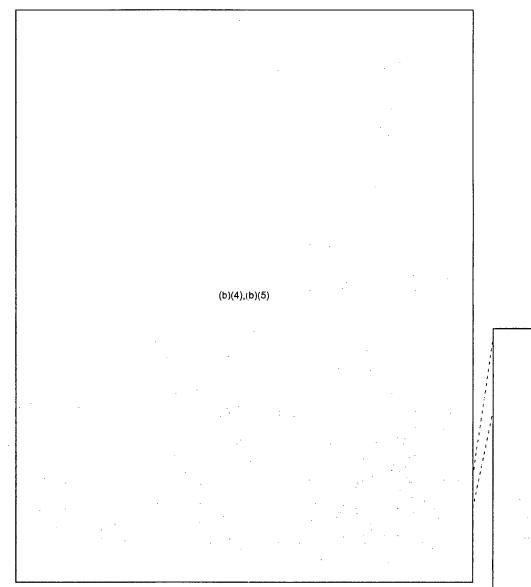
	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total		1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

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Page 14

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

Page 1

0400 Tuesday, April 05, 2011

(b)(4)

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)
· ·

# SPENT FUEL POOL STATUS (2100 April 4th)

Fukushima Dailchi Unit 1			
Amount of fuel:	292 bundles	(b)(4)	Ď
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 15:30	5 JT, a hydrogen explosion occurred during venting. The		
	(b)(4),(b)(5)		
Unit 1 Assessment:			
	(b)(4),(b)(5)		

Page 2

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	tor Safety Team's assessment and recommendations for the Fukushima-Daiichi ssments and recommendations are based on the best available technical	
information. We acknowledge that the information is subje	cc to change and refinement.	
Unit 1 Recommendations:		
-		
-	(b)(4),(b)(5)	
-		
Unit 1 Additional Considerations:		
-		
	(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)#/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 read energizing.	thed the unit, checking the integrity of equipment before (b)(4).(b)(5)	
61161 GIZI (G.	(b)(4).(b)(5)	

Page 3

The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Datichi 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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#### Unit 2 Recommendations:

- (b)(4),(b)(5) - Unit 2 Additional Considerations:	
Unit 2 Additional Considerations:	
_	
- (b)(4),(b)(5)	
Fukushima Dailchi 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:	Ful((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)

Page 4

### Unit 3 Recommendations:

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	······································	7		
-	(b)(4),(b)(5)			
-				
Unit 3 Additional Considerations:	•			
-	· · ·	7		
-	(b`(4),(b)(5)			
Fukushima Daiichi Unit 4				
Amount of fuel:	1331 bundles		(b)(4)	D
Last transfer from Reactor:	548 bundles (December 5 to December 10, 2010)			
Decay Heat (MWth):	1.86 MWtH		(b)(d)	
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) #/1)			
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper			
Fuel Pool Water Temperature:	42°C (JAIF 4/3)	1	(b)(4)	
Other: External AC power has re before energizing.	ached the unit, checking electrical integrity of equipment	۷		ىر
Unit 4 Assessment:				
	(b)(4),(b)(5)			

Page 5

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0400 Tuesday, April 05, 2011

EY 756 of 942

### Unit 4 Recommendations:

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

### Unit 4 Additional Considerations:

•		(b)(4),(b)(5)
<u>Fukushima D</u>	alichi Unit 5	
Amount of fue	el:	946 bundles
Last transfer	from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW): 0.		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		No data
Fuel Pool Level: Full		Full
Water Injection Method and Source:		Fuel pool cooling
Fuel Pool Water Temperature:		37.9°C (JAIF 4/5)
Other:		the unit, Unit 6 diesel generators available. Fuel Pool d (JAIF, NISA, TEPCO). Repairs complete on RHR ing.
Unit 5 Assessment:		

Stable.

Unit 5 Recommendations:

Page 6

-	(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)	]	
	Page 7 0400 Tuesday, April 05, 2011	

EY 758 of 942

-	(b)(4),(b)(5)
Fukushima Dalichi 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

Page 8

0400 Tuesday, April 05, 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

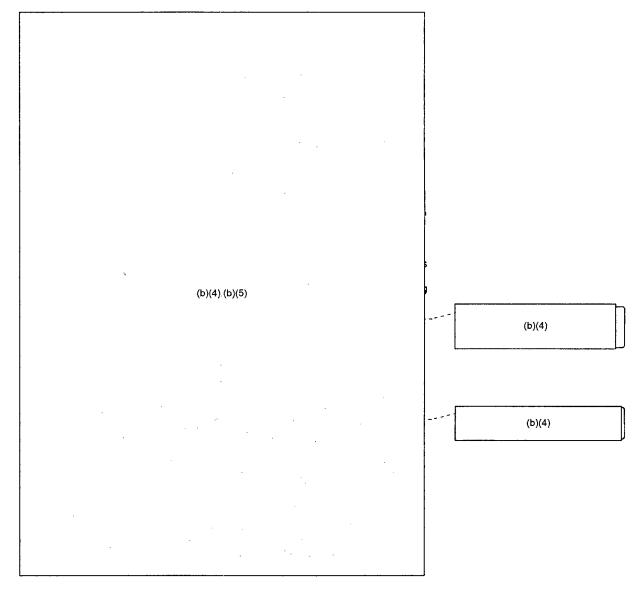
Page 9

0400 Tuesday, April 05, 2011

EY 760 of 942

### **ENCLOSURE 1**

1. EPRI recommendations March 18, 2011



Page 10

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

Page 11

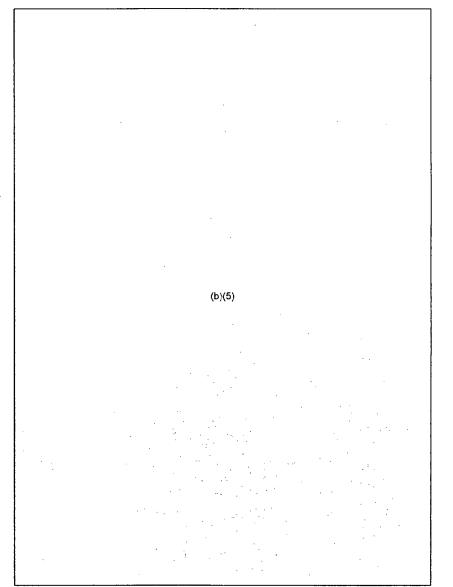
0400 Tuesday, April 05, 2011

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EY 762 of 942

### ENCLSOURE 2

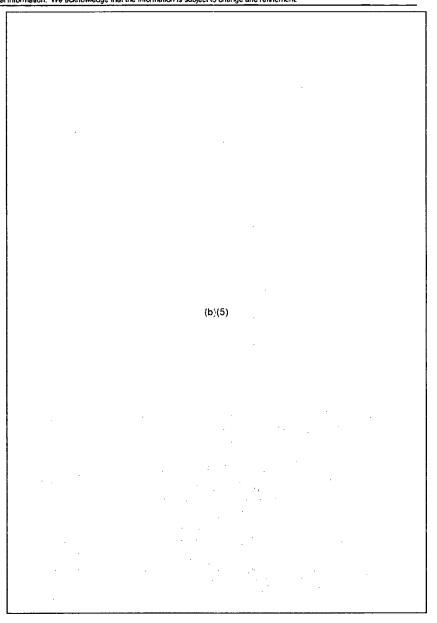
### SFP Criticality Potential, Kent Wood, March 4, 2011



Page 12

0400 Tuesday, April 05, 2011

EY 763 of 942



Page 13

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### 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	(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

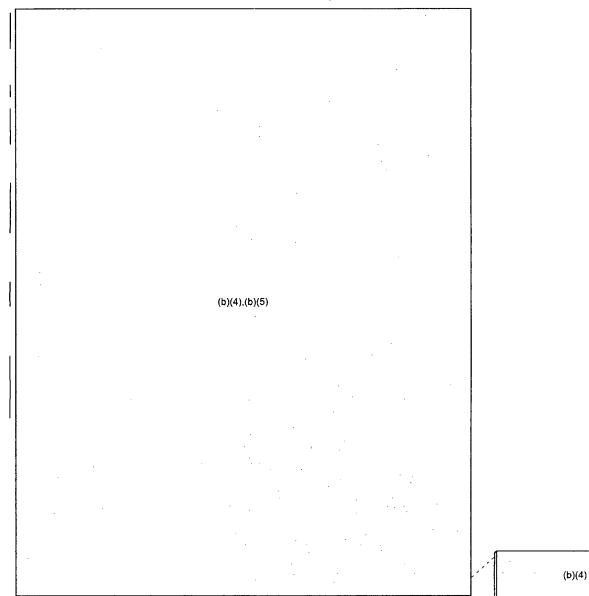
	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23. 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8. 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total	·	1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

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Page 14

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General Discussion of the Desired End State of all Spent Fuel Pools

Page 1

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

# SPENT FUEL POOL STATUS (2100 April 4th)

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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:		

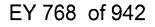
Page 2

0400 Tuesday, April 05, 2011

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The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Datichi 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 1 Recommendations: (b)(4),(b)(5) I ... Unit 1 Additional Considerations: (b)(4),(b)(5) (b)(5) Fukushima Daijchi 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 Drywell 3, 999 Rad/hour (R/hr); Torus 128 R/hr (CAMs) Area Radiation Levels: (b)(4) Full (b)(6) /3) Fuel Pool Level: Water Injection Method and Source: Fresh water injected to the spent fuel pool Fuel Pool Water Temperature: 71°C (TEPCO 4/5)

Page 3



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)

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Unit 2 Recommendations:

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

Unit 2 Additional Considerations:

-	(b)(4),(b)(5)		(b)(5)	
Fukushima Dailchi 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 bumper		(b)(5)	
Fuel Pool Water Temperature:	56°C (JAIF 4/5)	۰ <u>۱</u>	······································	

Page 4

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### Other:

# Unit 3 Assessment:

	(b)(4),(b)(5)	(b)(4)
Unit 3 Recommendations:		
-	(b)(4),(b)(5)	(b)(4),(b)(5)
Unit 3 Additional Considerations:		
-	(b)(4),(b)(5)	(b)(5)
Fukushima Dalichi 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) #/1)	
Water Injection Method and Source:	Periodic fresh water injected via concrete bumper	(b)(5)
Fuel Pool Water Temperature:	42°C (JAIF 4/3)	

Page 5

0400 Tuesday, April 05, 2011

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EY 770 of 942

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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:	
- - 1 -	(b)(4),(b)(5)
Unit 4 Additional Considerations:	
-	(b)(4),(b)(5)
Fukushima Dalichi 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

Page 6

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.

1

Unit 5 Recommendations:

-	(b)(4),(b)(5)
<u>Unit 5 A</u>	Additional Considerations:
-	(b)(4).(b)(5)
Fukush	ima Dailchi Unit 6

Amount of fu	el:	876 bundles		
Last transfer	from Reactor:	184 bundles (August 10-25 2010)		
Decay Heat (	MW):	0.7 (MW) (b)(6)		
Fuel Pool Str	uctural Support Integrity:	Not damaged (JAIF 4/4)		
Fuel Pool Lea	ak Integrity:	No data		
Criticality stat	tus:	No data		
Area Radiatio	on Levels:	No data		
Fuel Pool Lev	vel:	Full		
Water Injection	on 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)	C	
		the unit, Unit 6 diesel generators available. Fuel Pool ed (JAIF, NISA, TEPCO). Repairs complete on RHR ing.		

Unit 6 Assessment:

Page 7

### Relatively-Setable.

Unit	6 Recor	nmenda	tions:

-		(b)(4),(b)(5)
Unit 6 /	Additional Considerations:	· · · · · · · · · · · · · · · · · · ·
		(b)(4),(b)(5)
<u>Fukush</u>	nima Daiichi Common SFP	
Amoun	it of fuel:	6375 bundles
Last tra	ansfer 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 Po	ool Water Temperature:	28.0°C (TECPO 4/54
Other:		
Commo	on SFP_Assessment:	
Relativ	ely stable.	
Commo	on SFP Recommendations:	
- [	e and a second	(b)(4),(b)(5)

Common Additional Considerations:

Page 8

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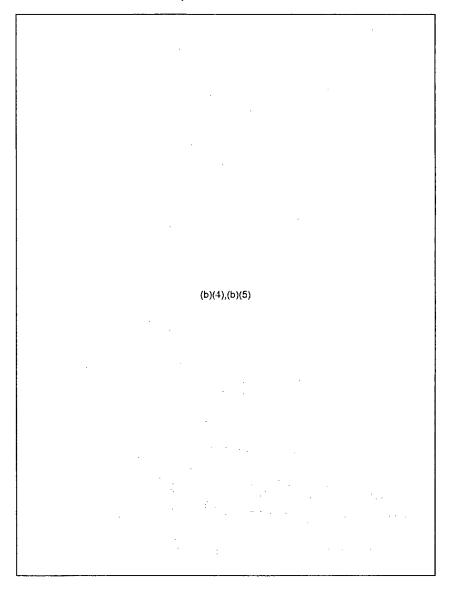
GEH – General Electric Hitachi INPO – Institute of Nuclear Power Operations JAIF – Japan Atomic Industrial Forum NISA – Nuclear and Industrial Safety Agency TEPCO – Tokyo Electric Power Company

Page 9

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### **ENCLOSURE 1**

1. EPRI recommendations March 18, 2011



Page 10

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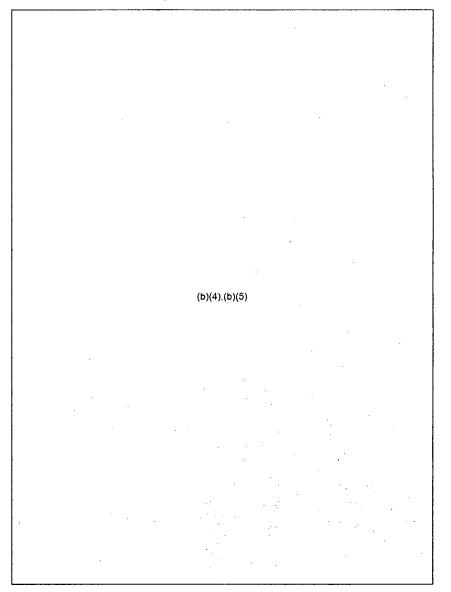
(b)(4),(b)(5)

Page 11

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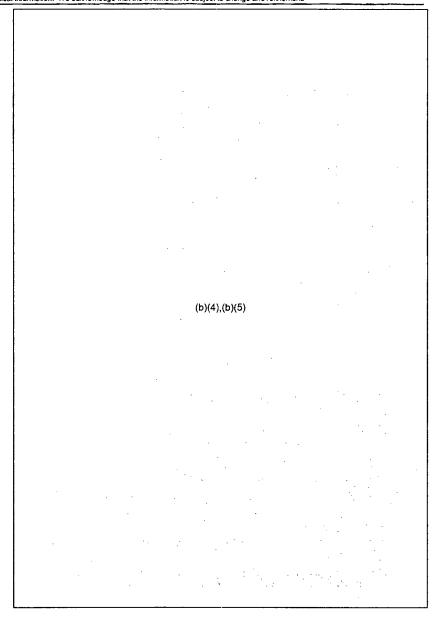
### ENCLSOURE 2

### SFP Criticality Potential, Kent Wood, March 4, 2011



Page 12 0400 Tuesday, April 05, 2011

EY 777 of 942



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Page 13

0400 Tuesday, April 05, 2011

# EY 778 of 942

### 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		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.

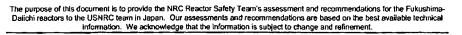
The most recent transfers of fuel from reactor cores to their spent fuel pool

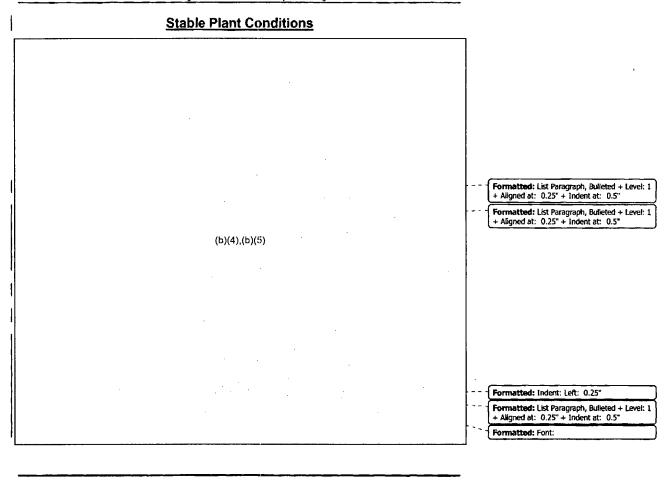
	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20. 2010 ~ September 25, 2010	116
Unit 3	June 23. 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total		1, 180

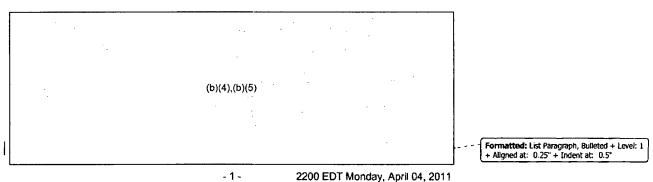
Note: Attachment 1 is Detailed Contents of Each Pool.

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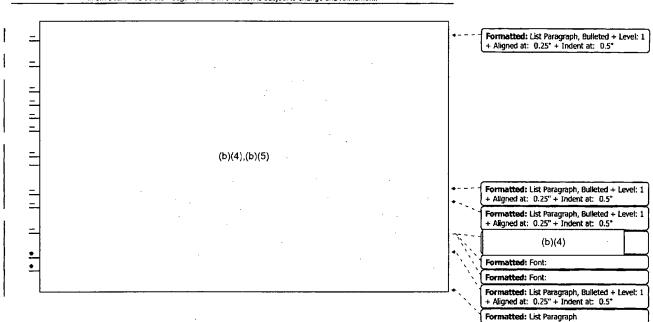
Page 14







EY 780 of 942

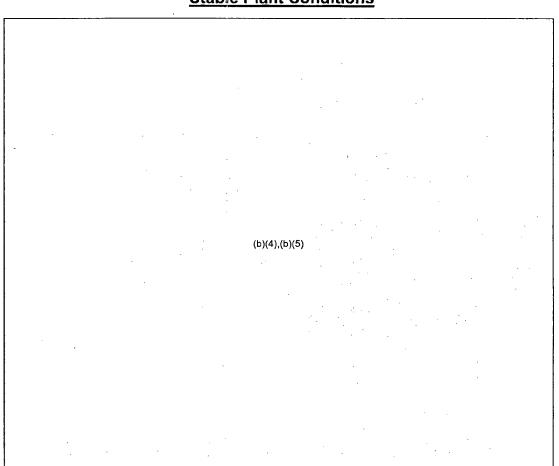


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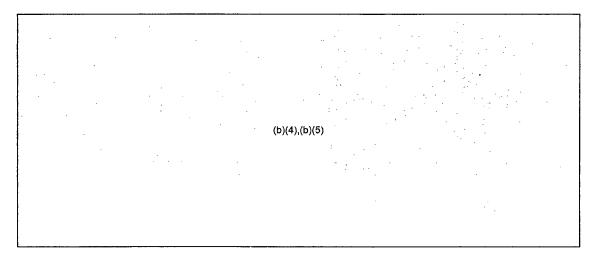
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2200 EDT Monday, April 04, 2011







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2200 EDT Monday, April 04, 2011

EY 782 of 942

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

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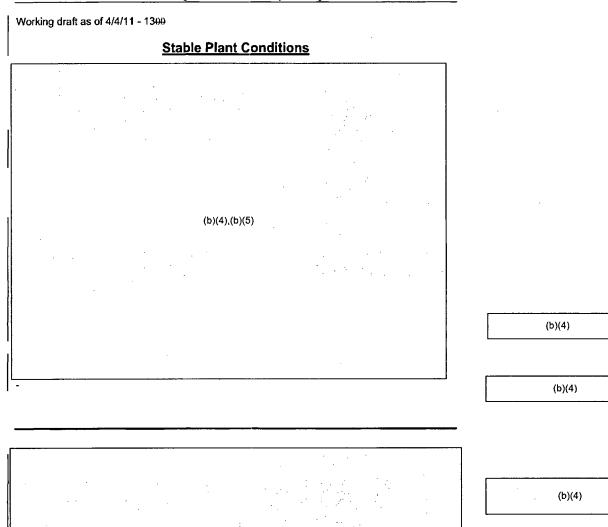
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- 2 - 2200 EDT Monday, April 04, 2011

EY 783 of 942

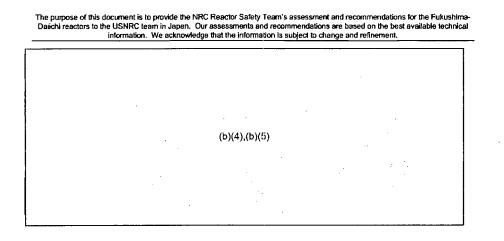
(b)(4),(b)(5)

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0330 EDT Monday, April 04, 2011

EY 784 of 942



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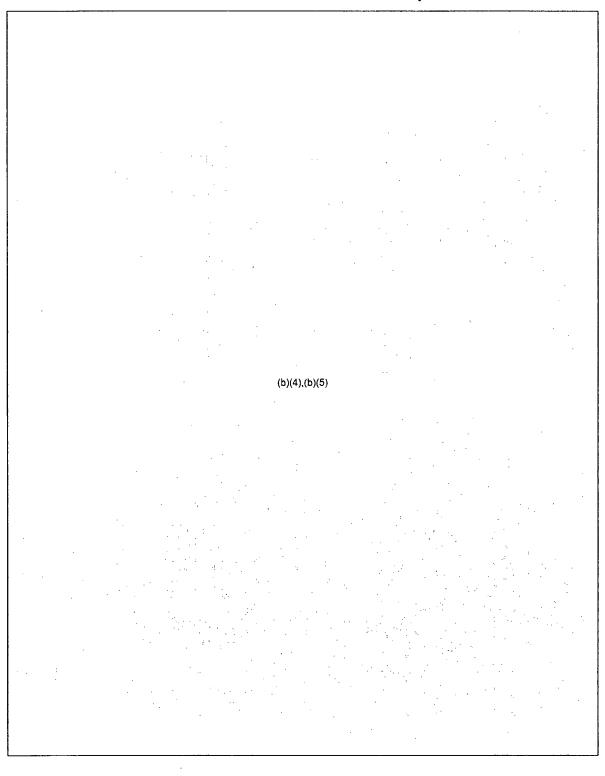
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0330 EDT Monday, April 04, 2011

EY 785 of 942



# General Discussion of the Desired End State of all Spent Fuel Pools

0400 Tuesday, April 05, 2011

EY 786 of 942

Page 1

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	(b)(4),(			
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# SPENT FUEL POOL STATUS (2100 April 4th)

Fukushima Dalichi Unit 1

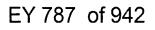
Amount of fuel:	292 bundles
Last transfer from Reactor:	64 bundles (March 29 to April 2, 2010)
Decay Heat [megawatt thermal (MWth)]:	0.7 MWth, evaporation rate 780 gallons per day
Fuel Pool Structural Support Integrity:	(b)(4),(b)(5)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area 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:

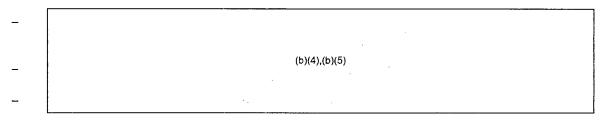
On March 12, 2011 at 15:36 JT, a hydrogen explosion occurred during venting. The (b)(4),(b)(5)

# Unit 1 Assessment:

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



### Unit 1 Recommendations:



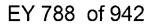
# Unit 1 Additional Considerations:

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

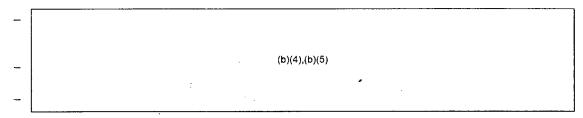
# Fukushima Daiichi Unit 2

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		
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 reac energizing.	hed the unit. checkina the intearity of eauipment before (b)(4),(b)(5)		
Unit 2 Assessment:			

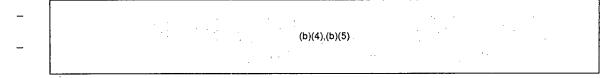
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	(b)(4),(b)(5)	•	



### Unit 2 Recommendations:



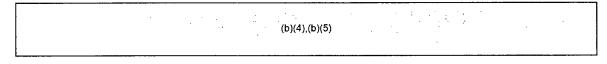
# Unit 2 Additional Considerations:



# 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)
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:	

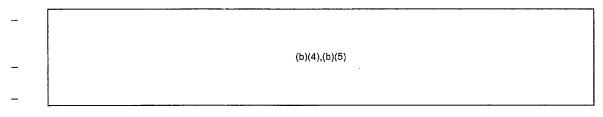
Unit 3 Assessment:



0400 Tuesday, April 05, 2011

EY 789 of 942

### Unit 3 Recommendations:



# Unit 3 Additional Considerations:

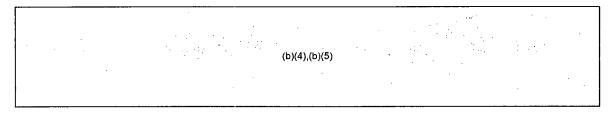
-	· · ·	
_	(b)(4),(b)(5)	

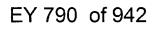
# Fukushima Daiichi Unit 4

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) \$/1)
Water Injection Method and Source:	Periodic fresh water injected via concrete pumper
Fuel Pool Water Temperature:	42°C (JAIF 4/3)

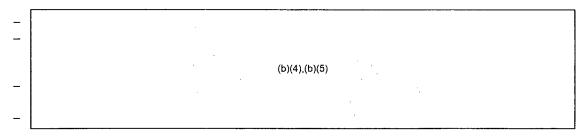
Other: External AC power has reached the unit, checking electrical integrity of equipment before energizing.

# Unit 4 Assessment:





### Unit 4 Recommendations:



# Unit 4 Additional Considerations:

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

# Fukushima Daiichi Unit 5

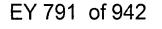
Amount of fuel:	946 bundles
Last transfer from Reactor:	120 bundles (January 8-13, 2011)
Decay Heat (MW):	0.8 MW (b)(6)
Fuel Pool Structural Support Integrity:	Not damaged (JAIF 4/4)
Fuel Pool Leak Integrity:	No data
Criticality status:	No data
Area Radiation Levels:	No data
Fuel Pool Level:	Fuli
Water 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:

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

0400 Tuesday, April 05, 2011



-	(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:

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

# Common Additional Considerations:

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-	(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

Page 8

0400 Tuesday, April 05, 2011



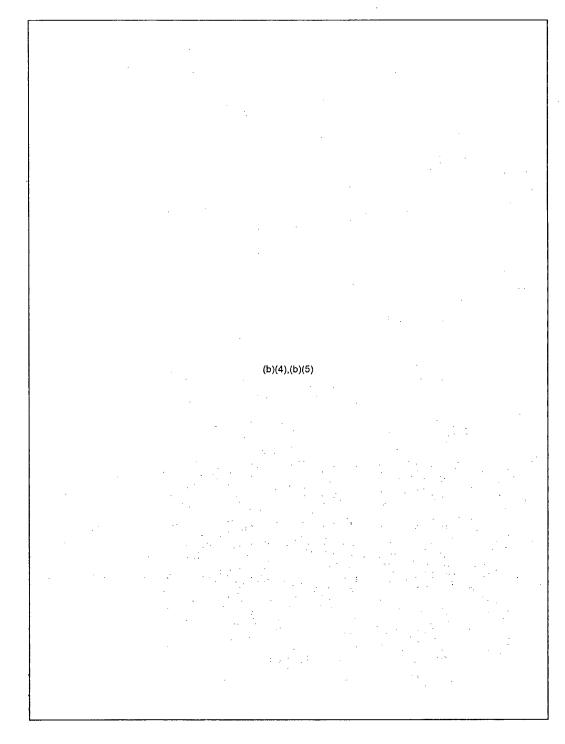
### ABBREVIATIONS:

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

0400 Tuesday, April 05, 2011

EY 794 of 942

# **ENCLOSURE 1**



### 1. EPRI recommendations March 18, 2011

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0400 Tuesday, April 05, 2011



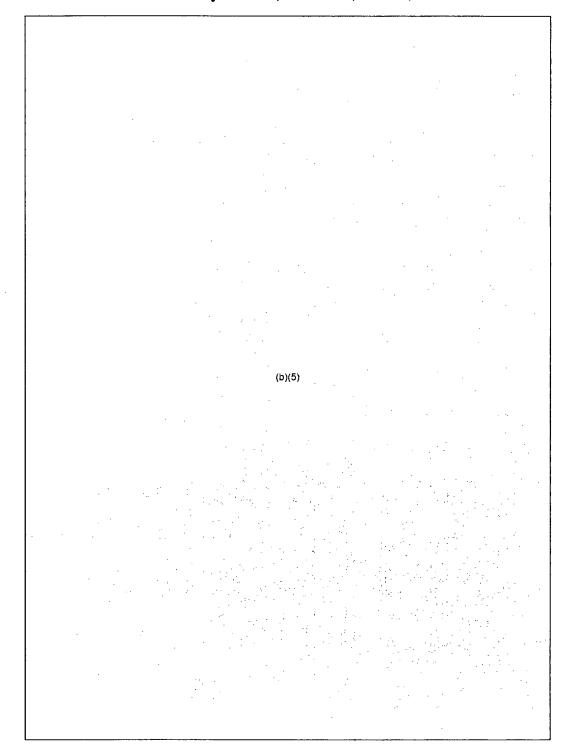
EY 795 of 942

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

0400 Tuesday, April 05, 2011



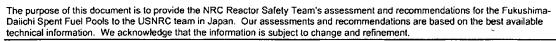
## **ENCLSOURE 2**

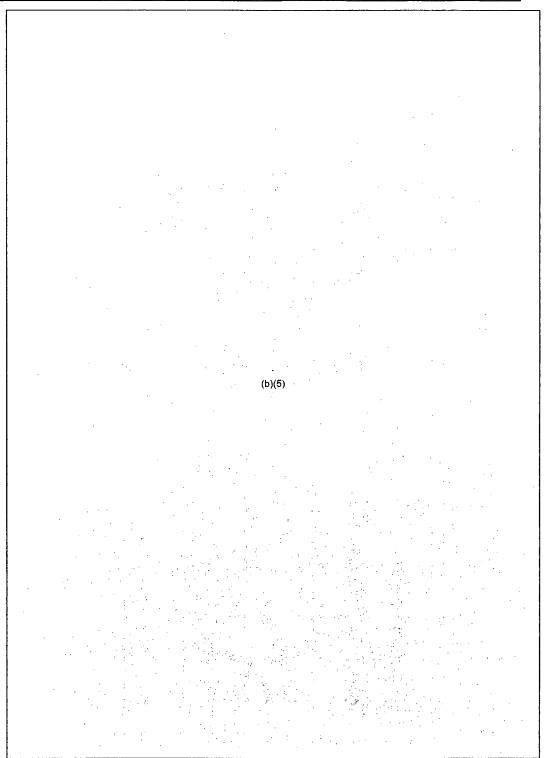


SFP Criticality Potential, Kent Wood, March 4, 2011

0400 Tuesday, April 05, 2011

EY 797 of 942





0400 Tuesday, April 05, 2011

EY 798 of 942

## **ENCLOSURE 3**

Spent fuel inventories at each unit of Fukushima Dailchi nuclear power station

	Reactor	Spent fuel pool
Unit 1		292
Unit 2		587
Unit 3		514
Unit 4	(5)(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.

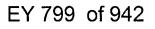
The most recent transfers of fuel from reactor cores to their spent fuel pool

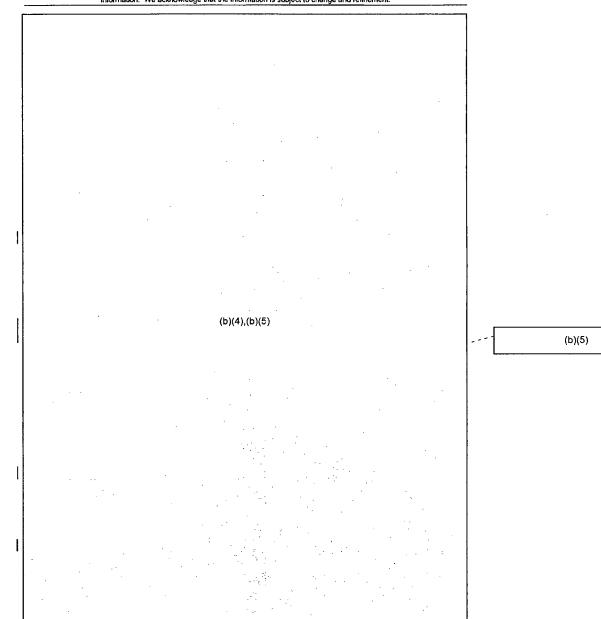
	Transfer date	Transferred fuels
Unit 1	March 29, 2010 ~ April 2, 2010	64
Unit 2	September 20, 2010 ~ September 25, 2010	116
Unit 3	June 23, 2010 ~ June 28, 2010	148
Unit 4	December 5, 2010 ~ December 10, 2010	548
Unit 5	January 8, 2011 ~ January 13, 2011	120
Unit 6	August 20, 2010 ~ August 25, 2010	184
Total		1, 180

Note: Attachment 1 is Detailed Contents of Each Pool.

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0400 Tuesday, April 05, 2011





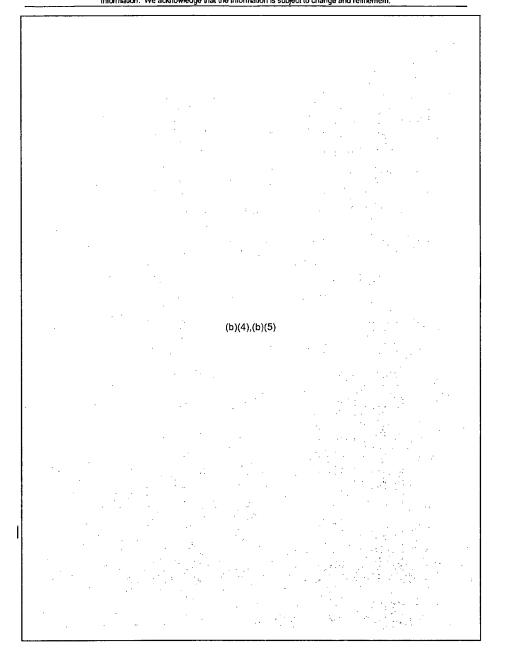
The purpose of this document is to provide the NRC Reactor Safety Team's assessment and recommendations for the Fukushima-Dailchi reactors to the USNRC team in Japan. Our assessments and recommendations are based on the best available technical Information. We acknowledge that the information is subject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

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0230 EDT Monday, April 04, 2011

EY 800 of 942



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. Dur 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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0230 EDT Monday, April 04, 2011

EY 801 of 942

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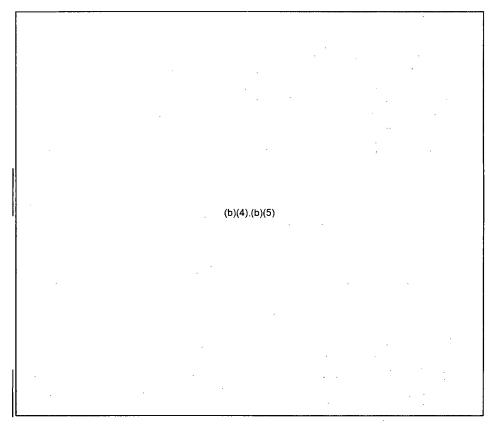
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0230 EDT Monday, April 04, 2011

### ENCLOSURE 1

Calculated the injection rate as follows based on TRACG decay heat (1979 ANS 5.1).



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0230 EDT Monday, April 04, 2011

EY 803 of 942

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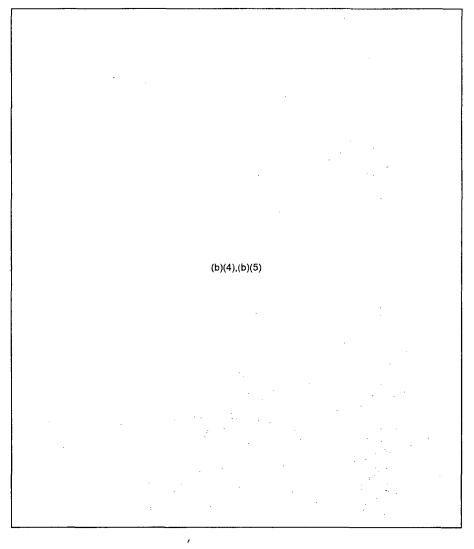
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0230 EDT Monday, April 04, 2011

EY 804 of 942

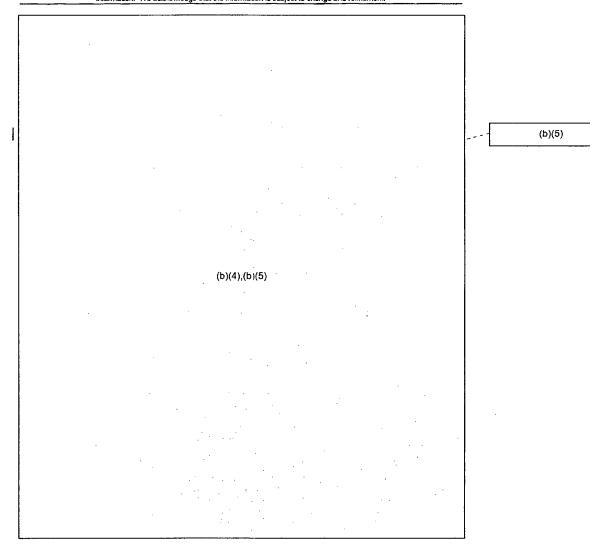
### ENCLOSURE 2

#### CONTAINMENT BYPASS



6 0230 EDT Monday, April 04, 2011

EY 805 of 942



Feedwater Check Valye Leakage

(b)(4),(b)(5) 7

0230 EDT Monday, April 04, 2011

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

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0230 EDT Monday, April 04, 2011

#### -Official-Use Only

#### RST Fuel Pool Assessment of Fukushima Dailchi 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-Dailchi 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)	
(0)(4),(0)(0)	

### UNIT ONE

#### **UI 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

Page 1

EY 808 of 942

### -Official Use Only

#### RST Fuel Pool Assessment of Fukusbima 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.

### **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:

Page 2

# EY 809 of 942

#### -Official Use Only RST Fuel Pool Assessment of Fukushima Daiichi Units 1 through 4 (REV 0), Based on most recent available data and input from INPO, GEH, EPRJ, 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.

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:** 

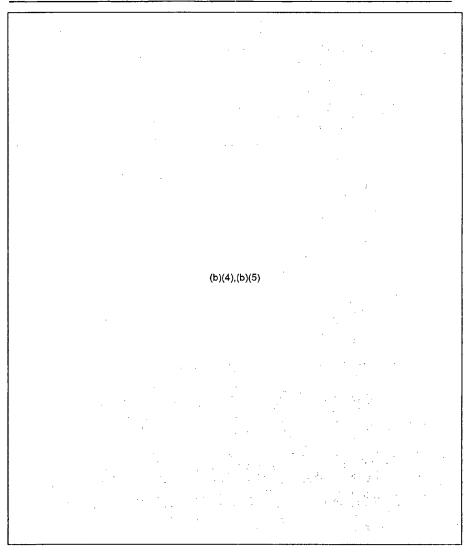
Page 3

EY 810 of 942

#### Official Use Only RST Fuel Pool Assessment of Fukusbinia 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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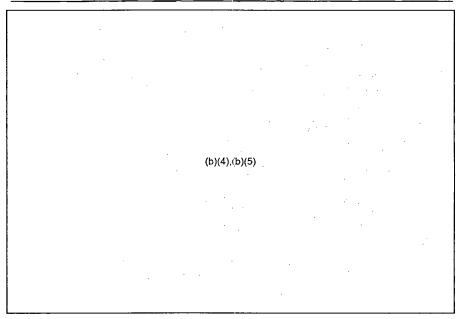
Page 4

EY 811 of 942

### Official-Use Only

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Spent fuel inventories at each unit of Fukushima Daiichi nuclear power station

Reactor		Spent fuel pool
Unit I		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:

		. •	· .
	S		· · ·
	(b)(4),(b)(5)		

#### -Official Use Only

#### 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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### Rad levels: 11 mR/hr at gate (variable) (TEPCO 0800 JDT 3/30)

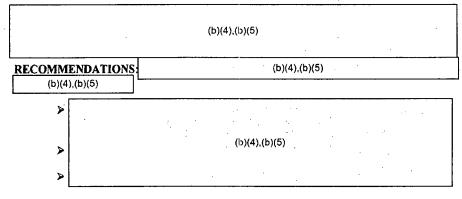
#### Other: Electric power available, equipment testing in progress (JAIF, NISA, TEPCO)

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),(c)(5)

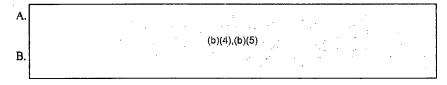
Reactor water is in the Turbine Building basement (NISA). (b)(4),(b)(5)

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

### ASSESSMENT:



**Additional Considerations** 



UNIT TWO

#### -Offi<del>cial Use Only</del> 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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ASSUMPTIONS: (based on input from multiple data source: JAIF, NISA, TEPCO, & GEH)

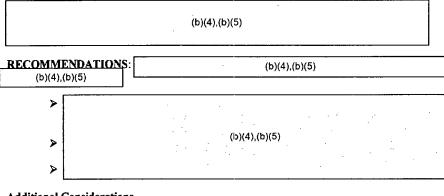
SFP Status:	(b)(4),(b)(5)	
	(b)(4).(b)(5)	1

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 b	pefore
	energizing.	(b)(4),(b)(5)	

### ASSESSMENT:



### Additional Considerations

<b>A</b> .	· · ·	(b)(4),(b)(5)	×	

### -Official Use Only-

#### RST Fuel Pool Assessment of Fukushima Daikchi 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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-			 
В.	· · ·	(b)(4),(b)(5)	
1			
		and the second	

### UNIT THREE

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

(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)			
>					

#### -Official Use-Only-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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### Additional Considerations

Α.	
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)

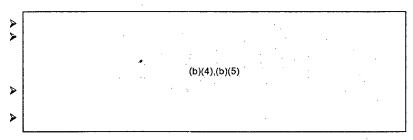
#### ASSESSMENT:

(b)(4),(b	
	)(5)
RECOMMENDATIONS:	(b)(4),(b)(5)

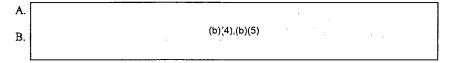
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**Additional Considerations** 



### 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

### -Official Use Only

# 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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### Page 12

EY 819 of 942

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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

#### - Official-Use Only-RST Fuel Pool Assessment of Fukushima Daikchi Units 1 through 4 (REV 0), Based on most recent available data and input from ENPO, CEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

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Spent fuel inventories at each unit of Fukushima Dalichi nuclear power station

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		Reactor	Spent fuel pool
Unit 1			292
Unit 2			587
Unit 3			514
Unit 4		(5)(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

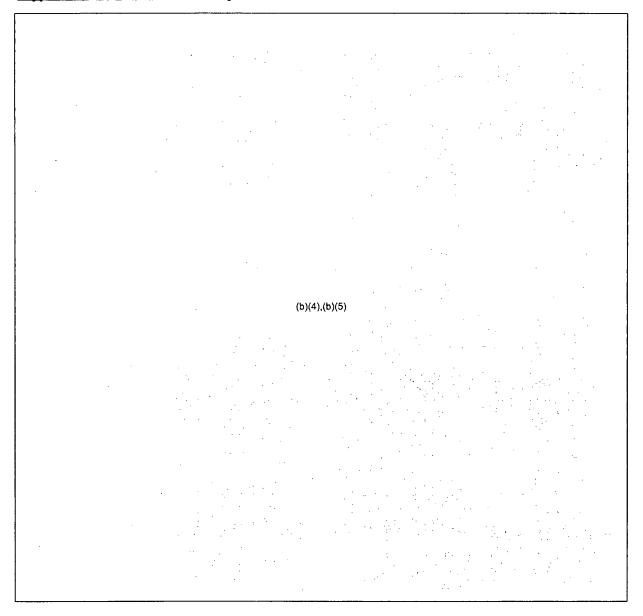
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### --Official Use Only-Supplemental Information on Venting (Q385) – Rev. 6 Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE

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# Supplemental Information on Venting

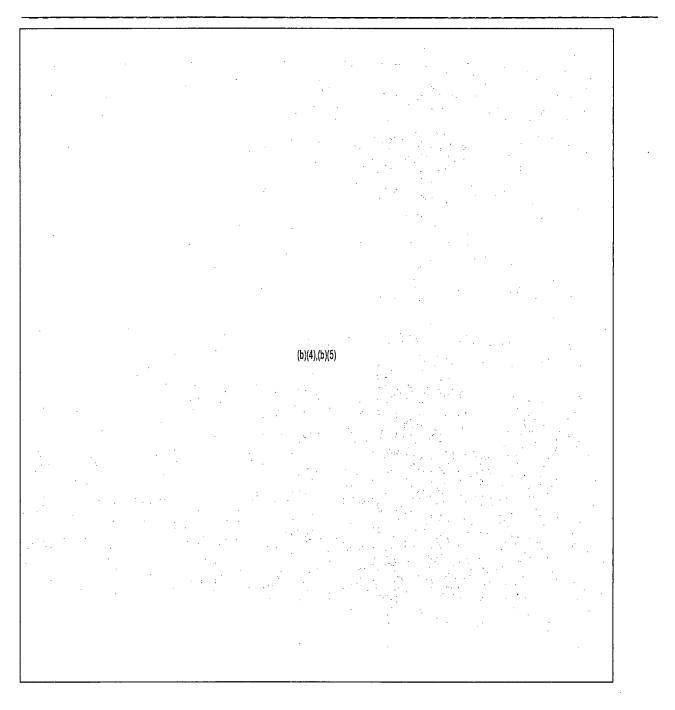


EY 822 of 942

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# 2200 Hrs 04/02/2011

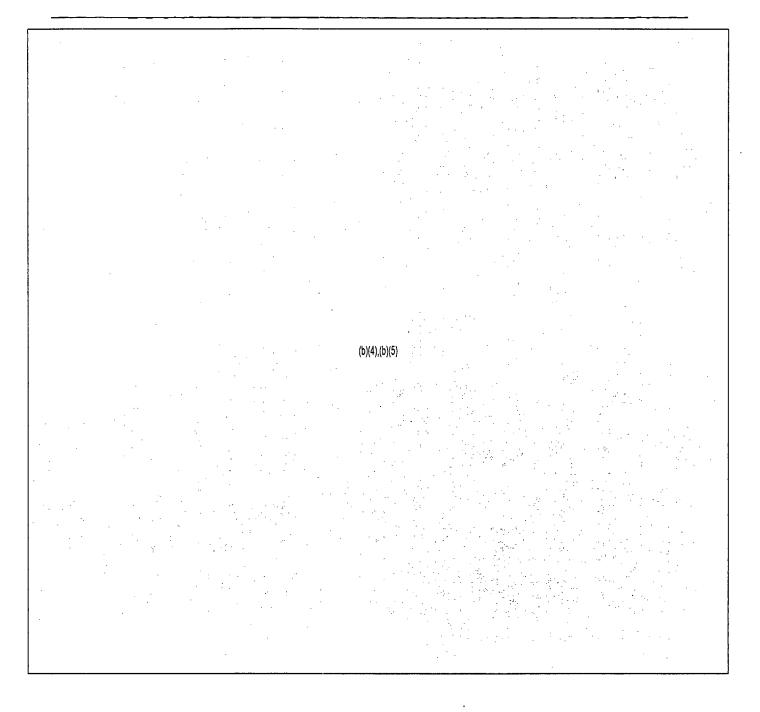
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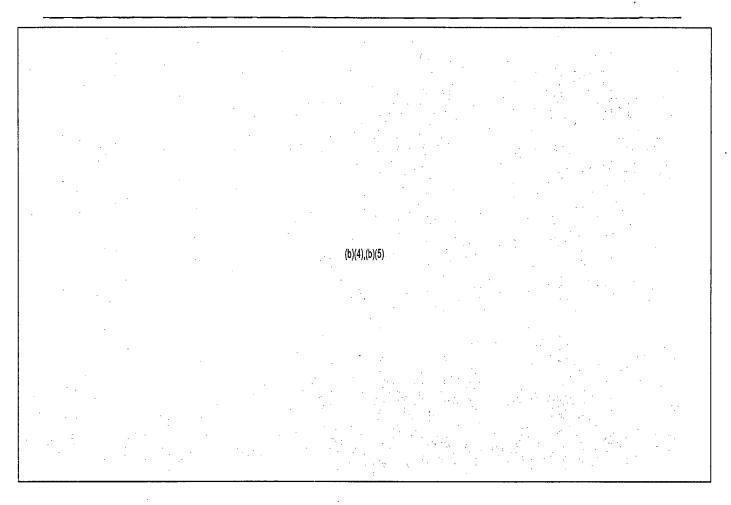


EY 824 of 942

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EY 825 of 942

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Radiological considerations:

		· · · · · · · · · · · · · · · · · · ·	 	
	•	(b)(4),(b)(5)		
Drywell radiation levels:			 	

(b)(4),(b)(5) <u>Meteorological conditions</u> (b)(4),(b)(5) (b)(4),(b)(5)		
Meteorological conditions:		
		(b)(4),(b)(5) •
	Meteorological conditions	(b)(4).(b)(5)

EY 826 of 942

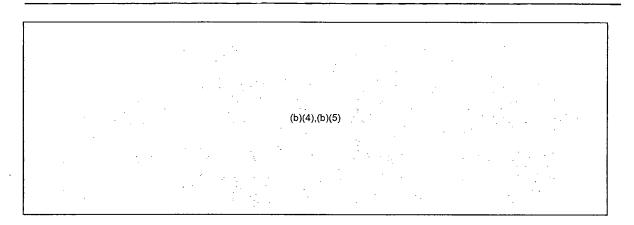
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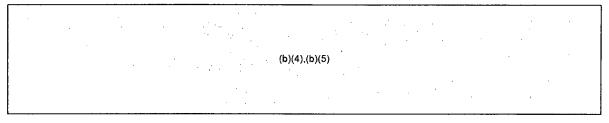
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### 1F1 vent status:

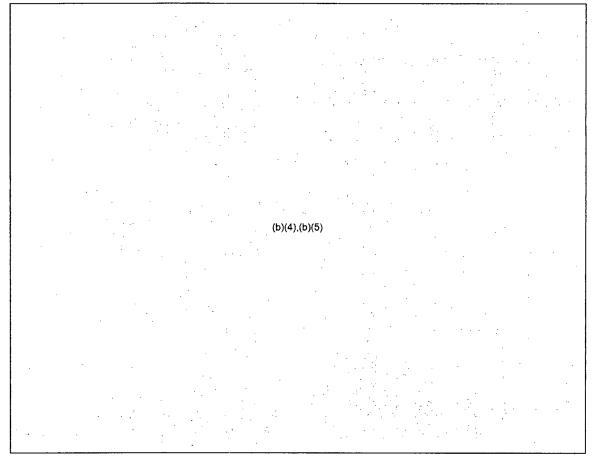


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## Generic Consideration of Containment Venting (EPRI TBR & BWR EPG/SAG)



### 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

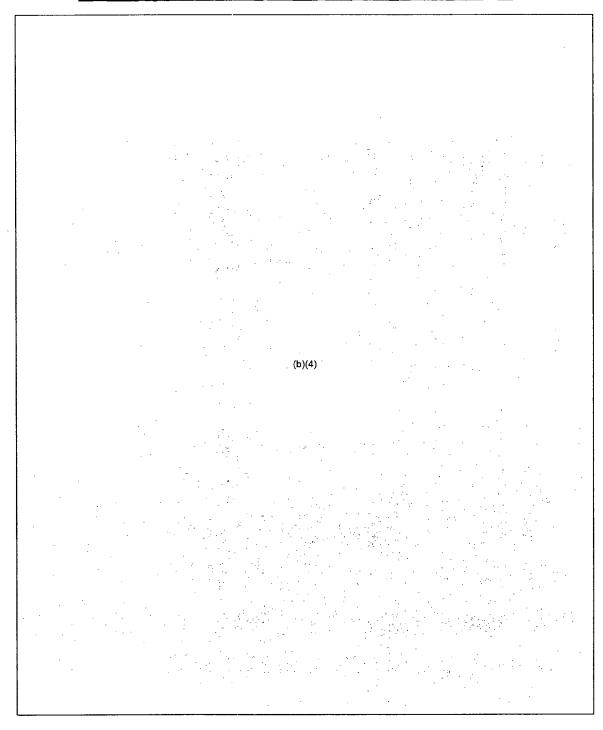
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# Key Agency/Organization Input to Supplemental Information on Venting (REV 6) Document

# Table of Senior/Approving Officials

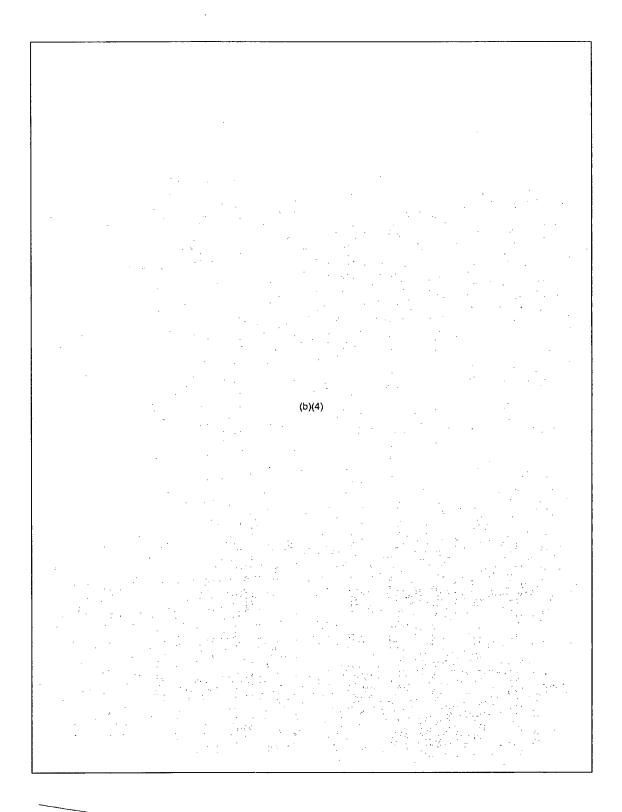
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ORGANIZATION	STATEMENT	OFFICIAL	TITLE	AS REPORTED BY
Naval Reactors,				
KAPL & BETTIS				
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GE Hitachi				• • •
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EY 829 of 942



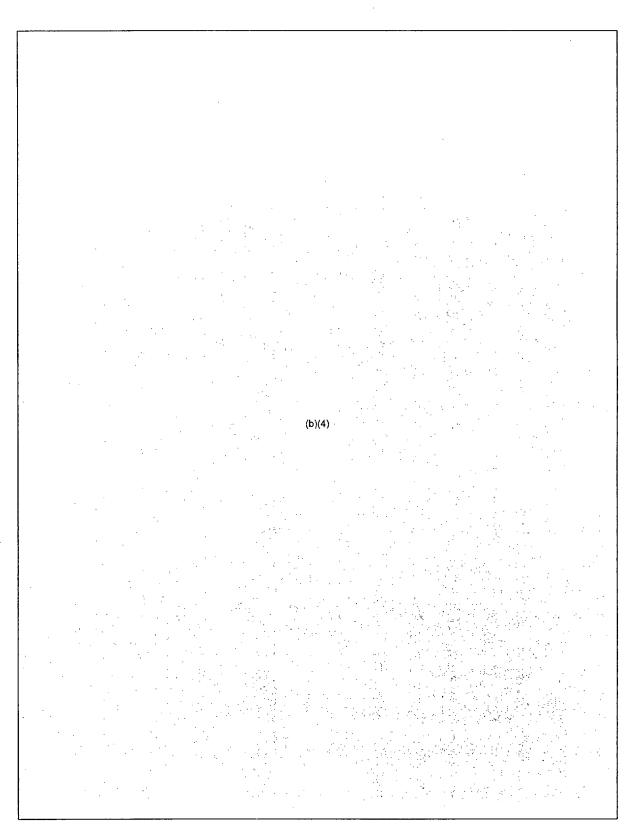
DRAFT Proposal for inclusion into Rev 1 of RST Assessment Document

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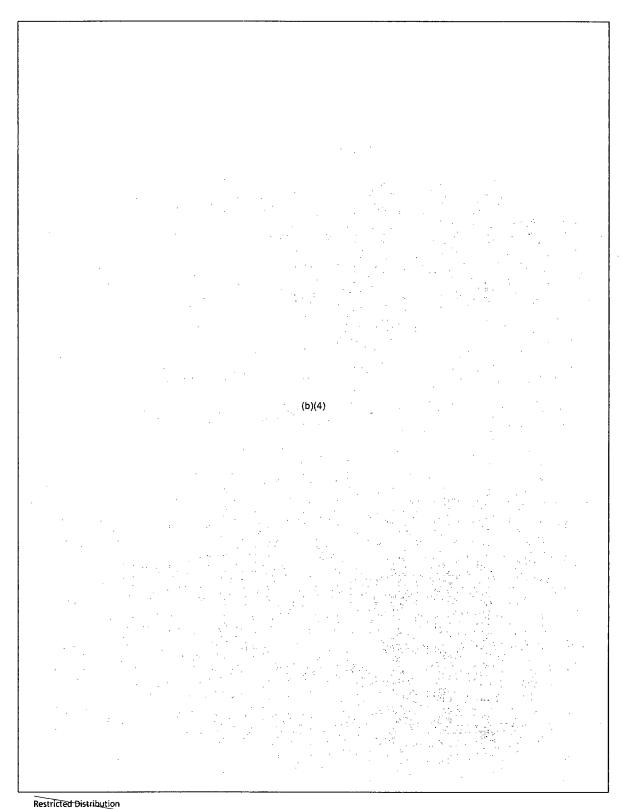


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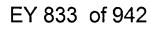
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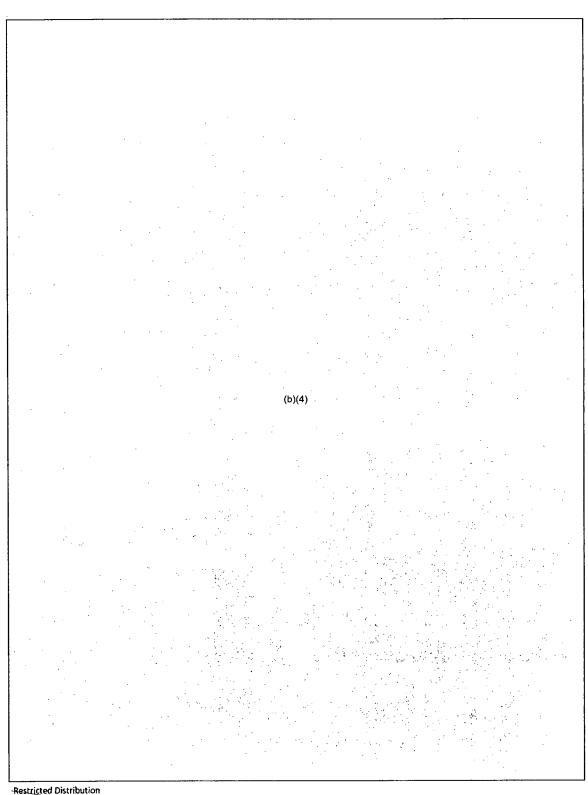


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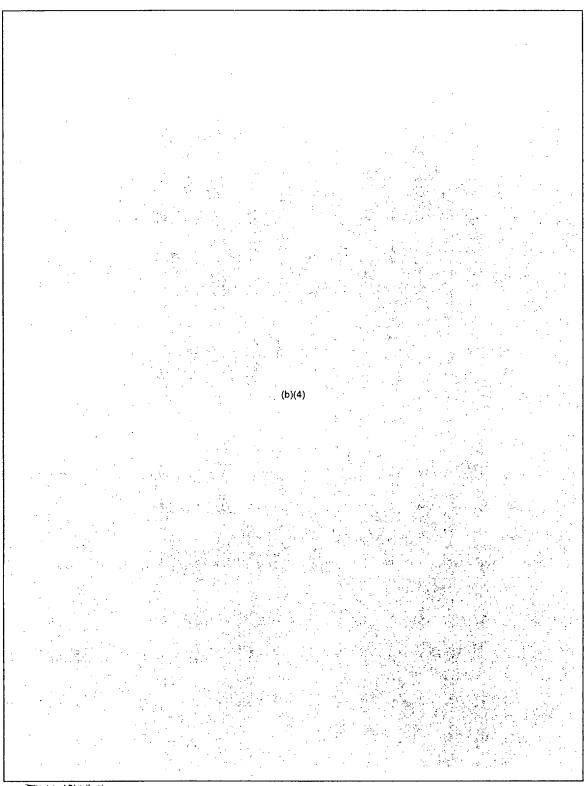
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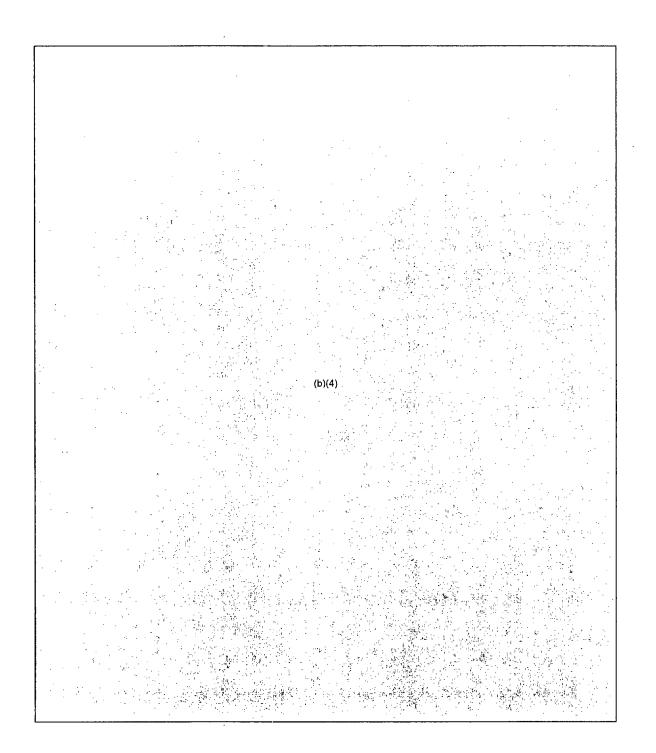
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EY 834 of 942



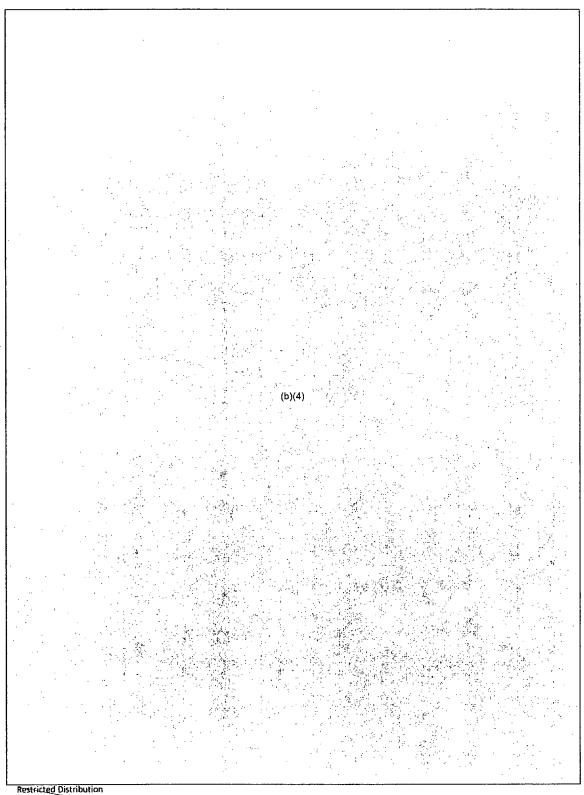
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EY 835 of 942



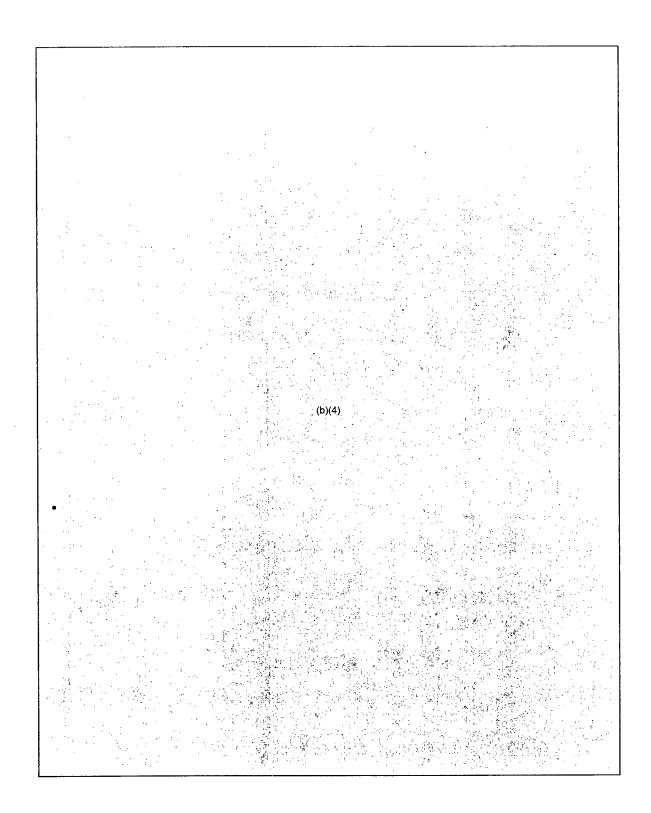
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EY 836 of 942



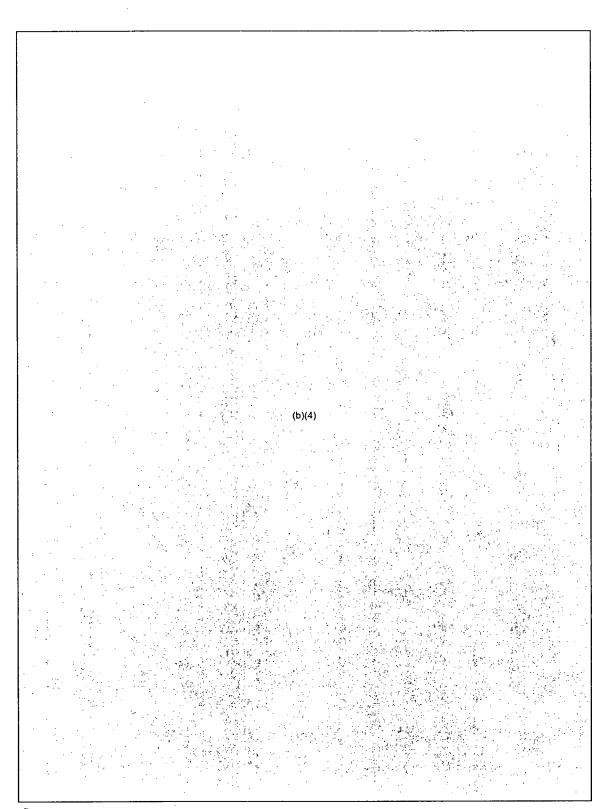
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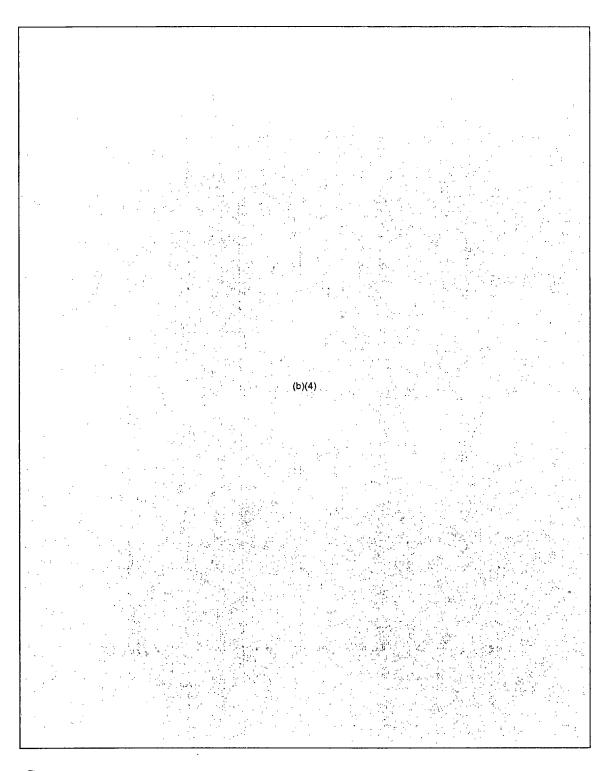
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EY 838 of 942



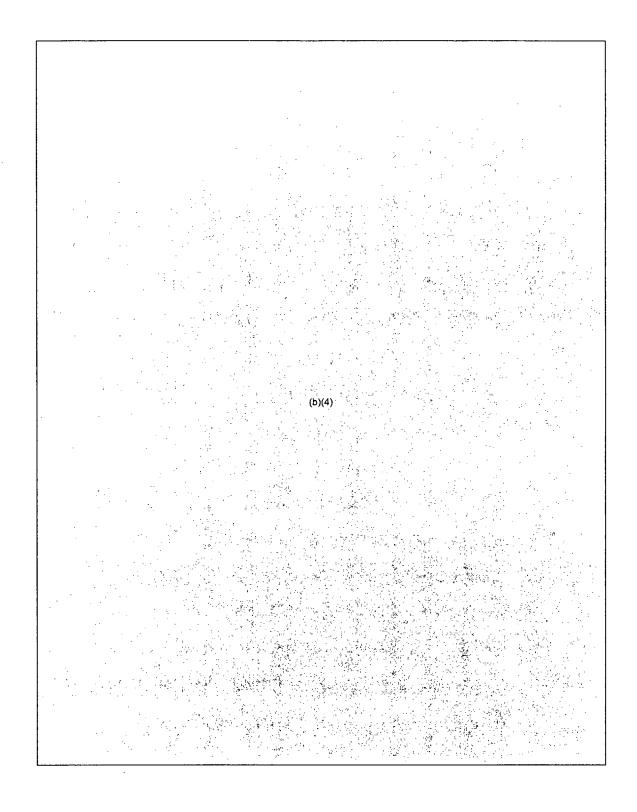
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EY 839 of 942



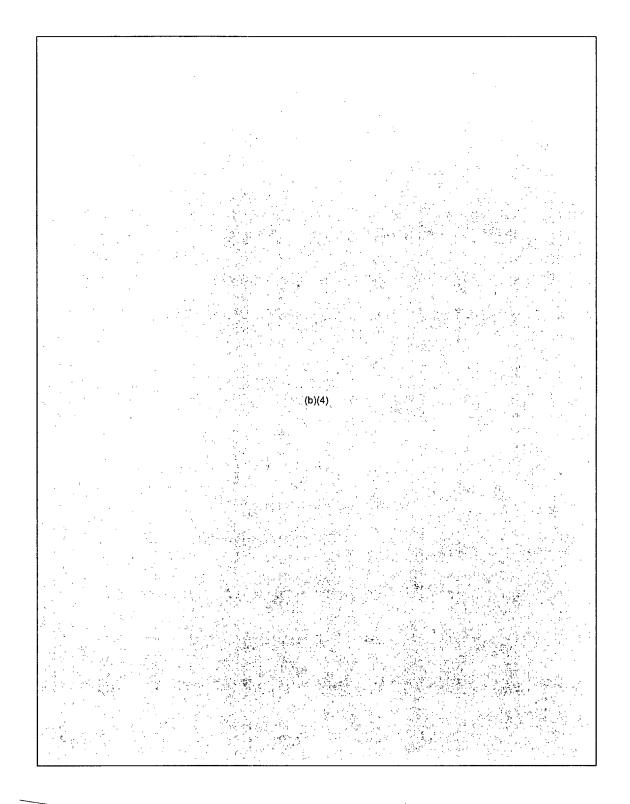
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EY 840 of 942

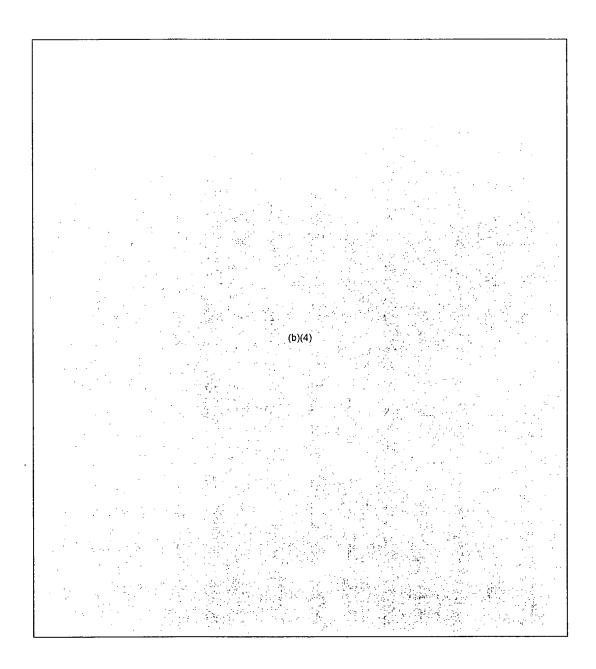


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EY 841 of 942

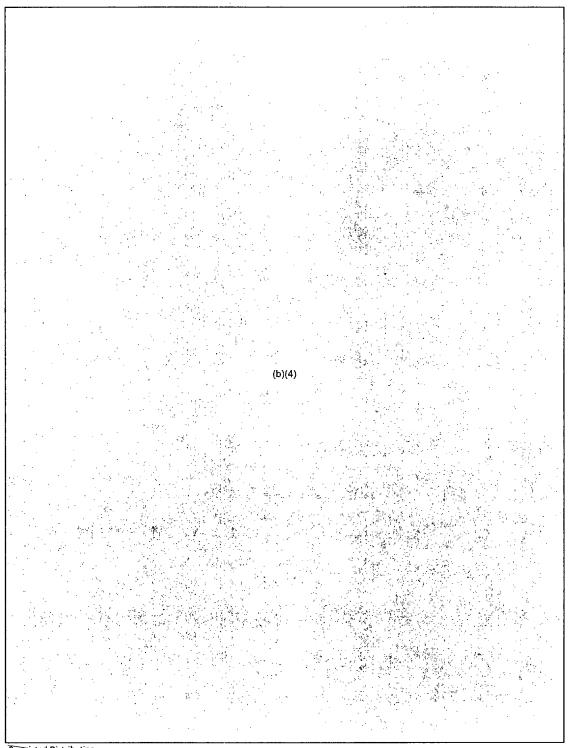


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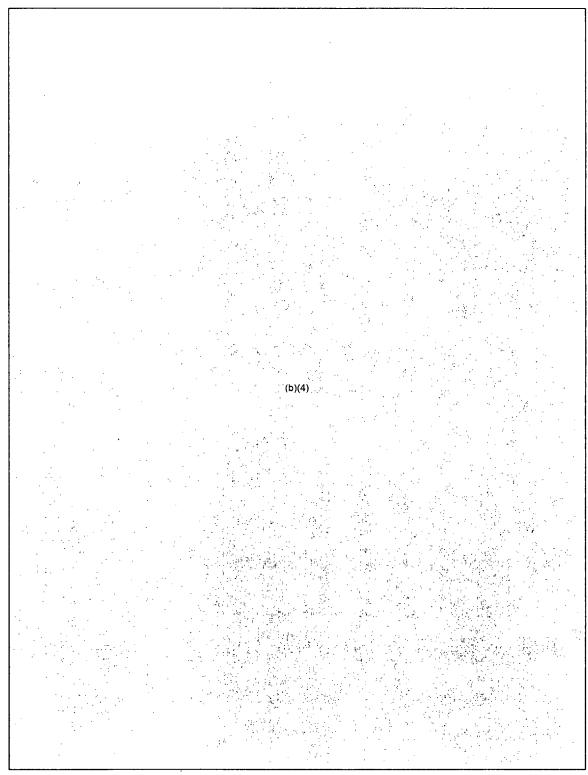
EY 843 of 942



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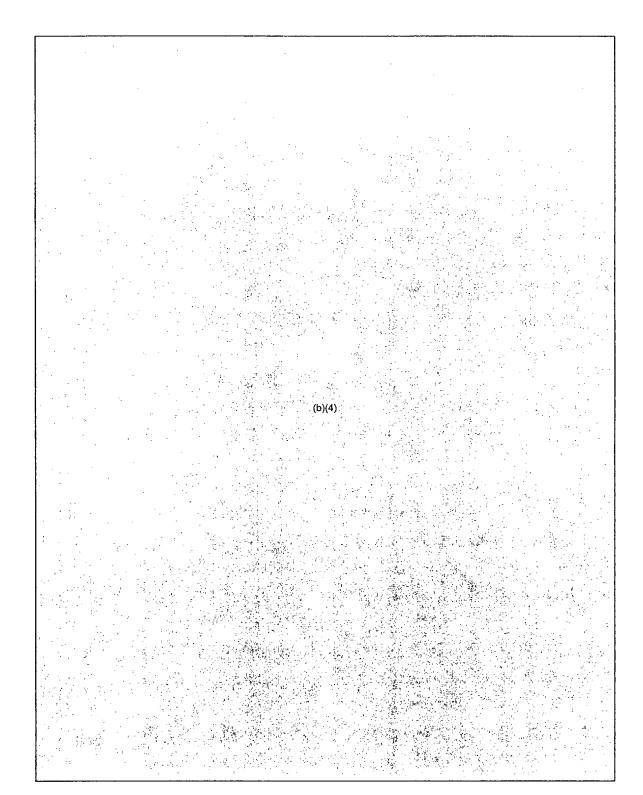
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EY 844 of 942



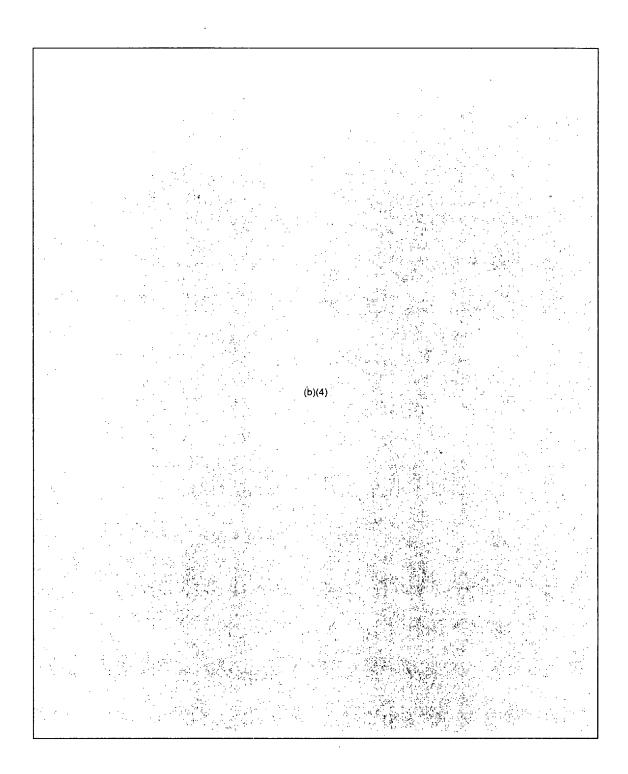
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EY 845 of 942



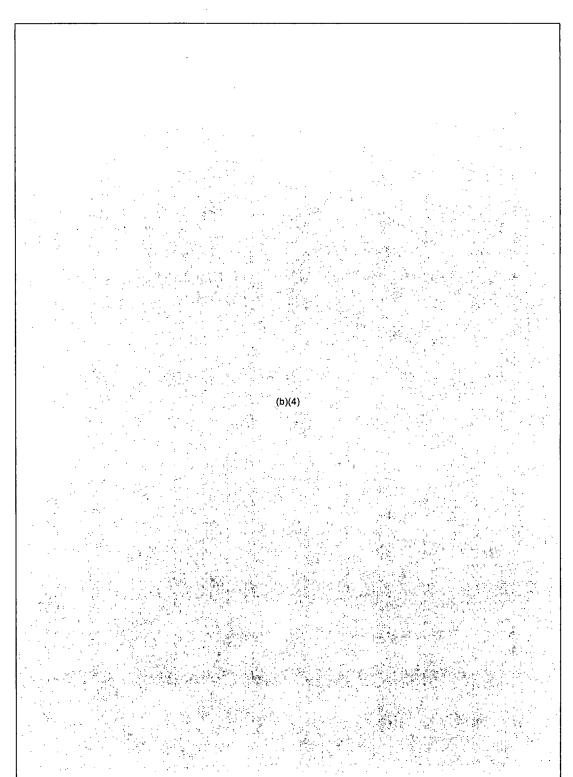
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EY 846 of 942



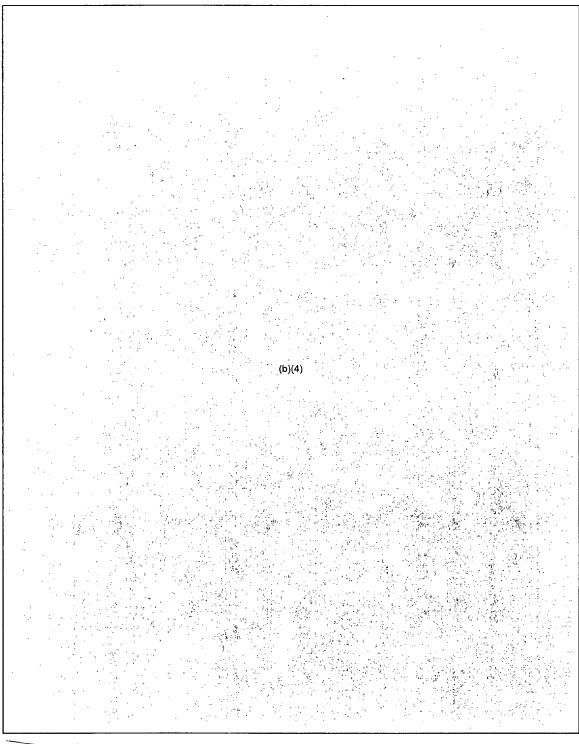
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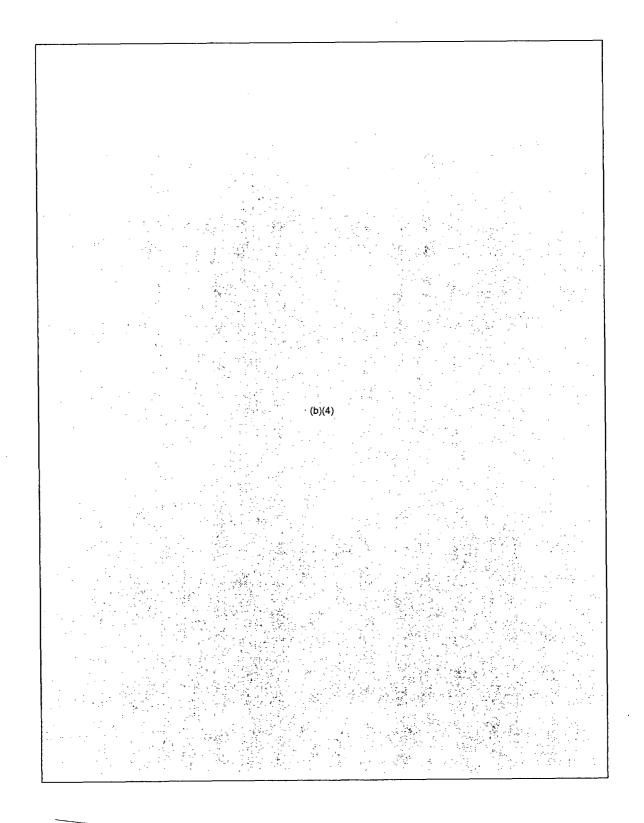
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EY 848 of 942

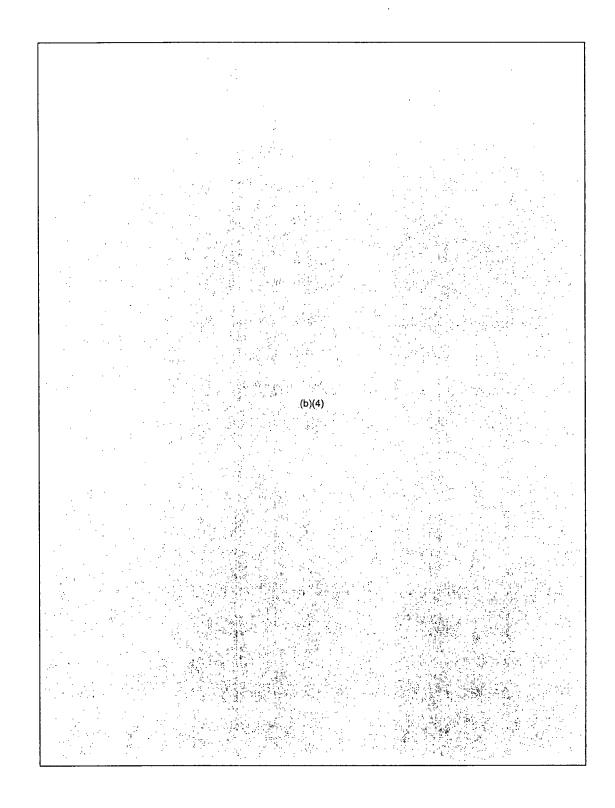


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EY 849 of 942

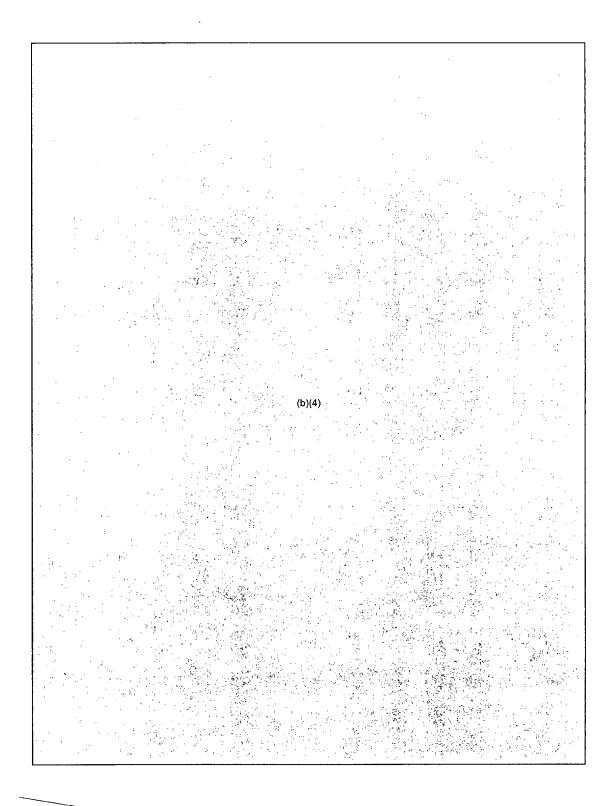


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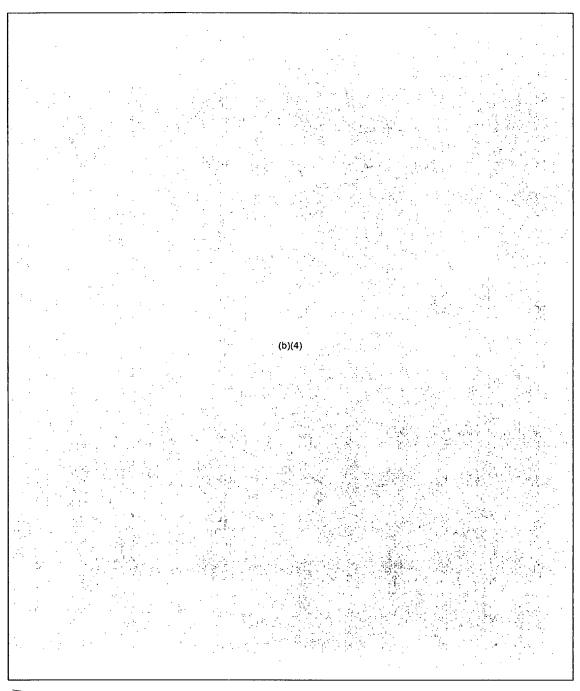
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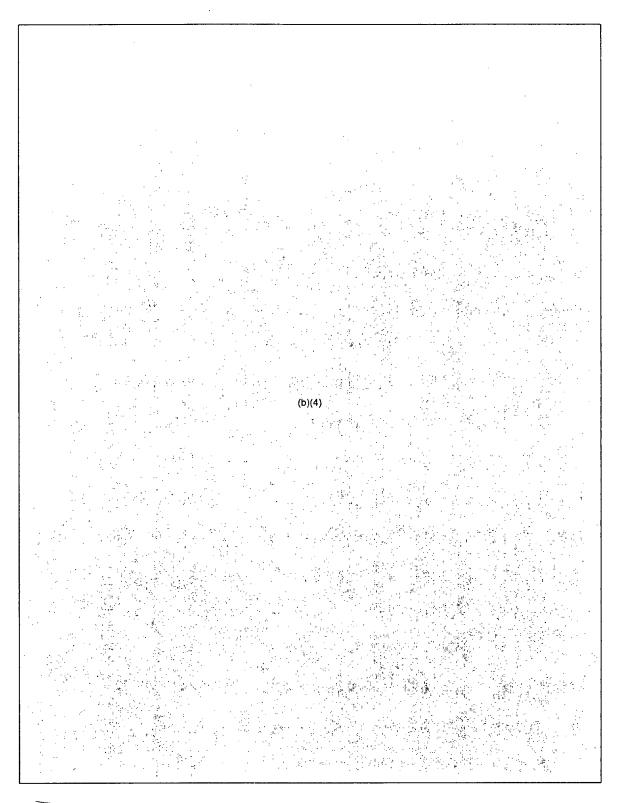
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EY 852 of 942



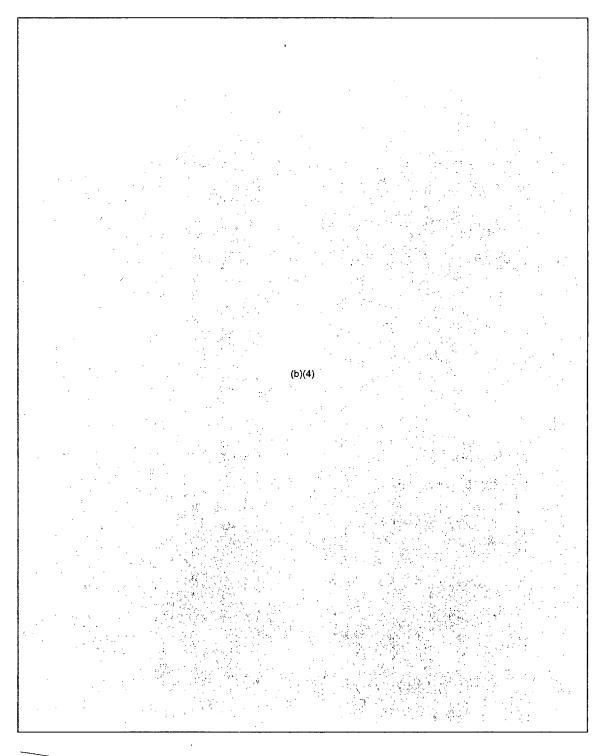
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EY 853 of 942



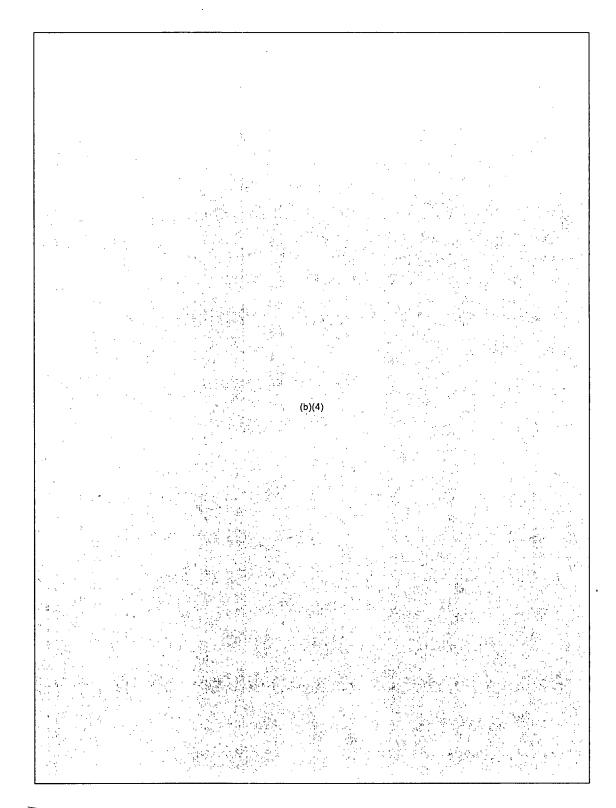
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EY 854 of 942



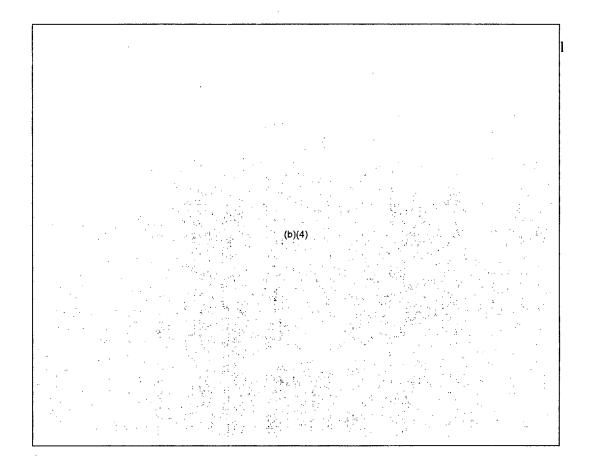
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EY 855 of 942



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EY 856 of 942

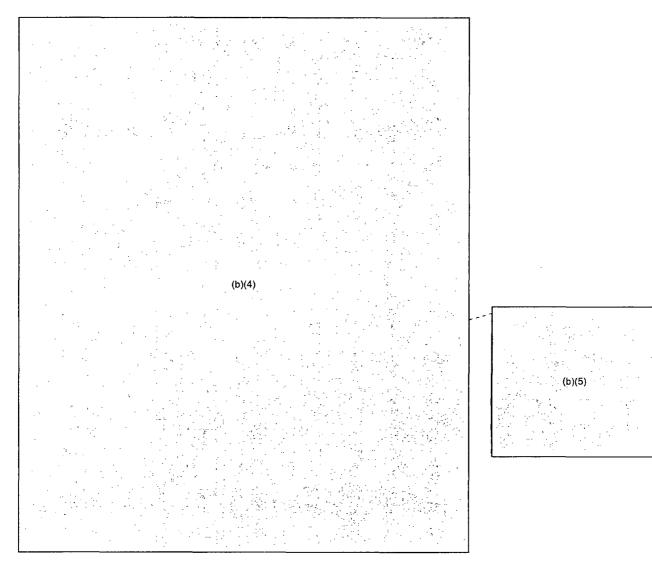


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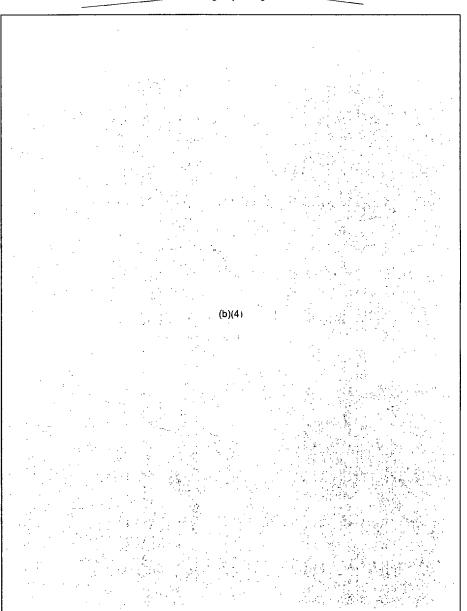
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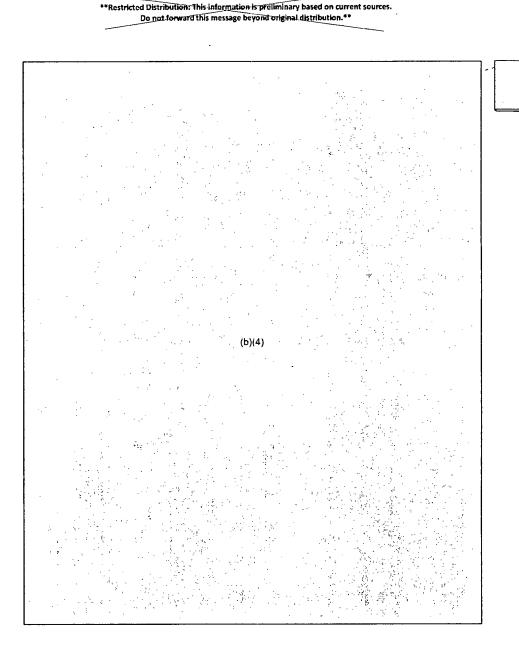
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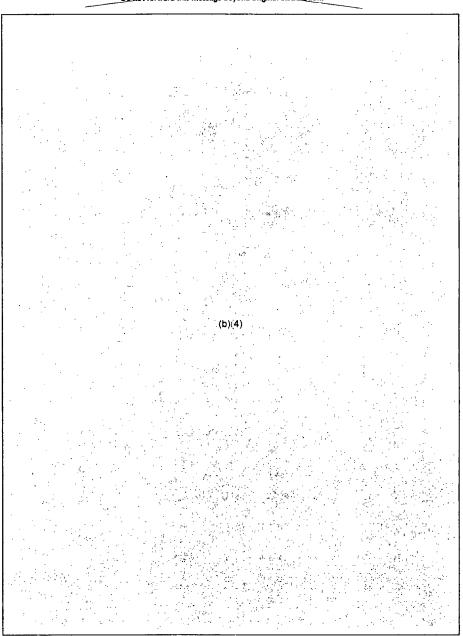
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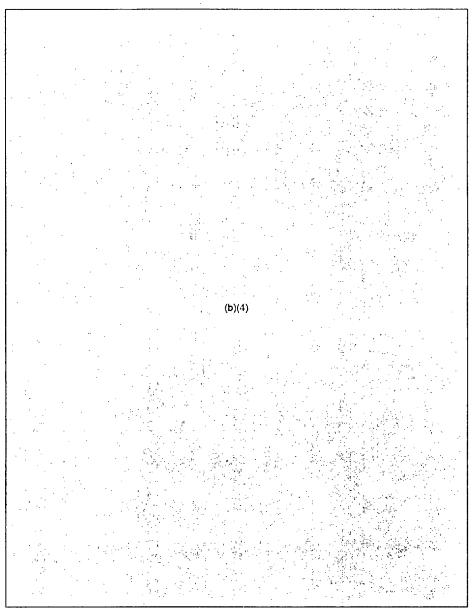
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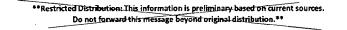
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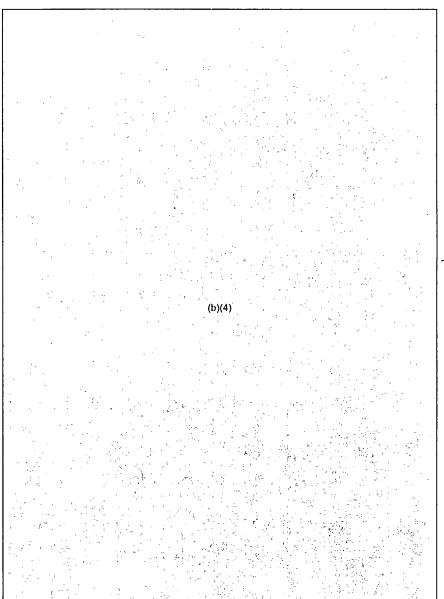
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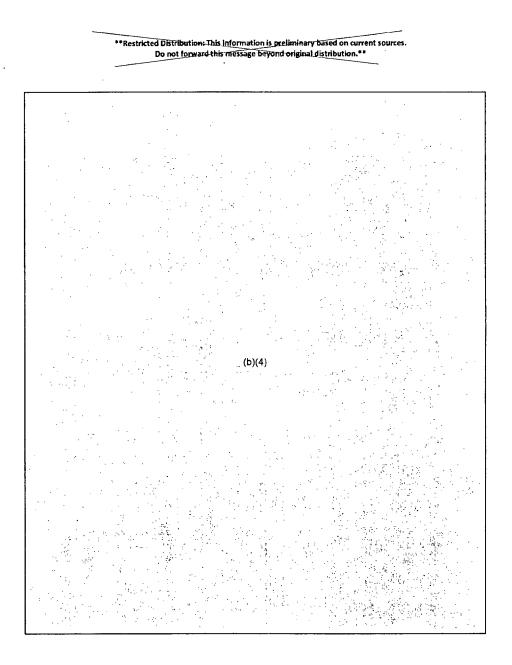






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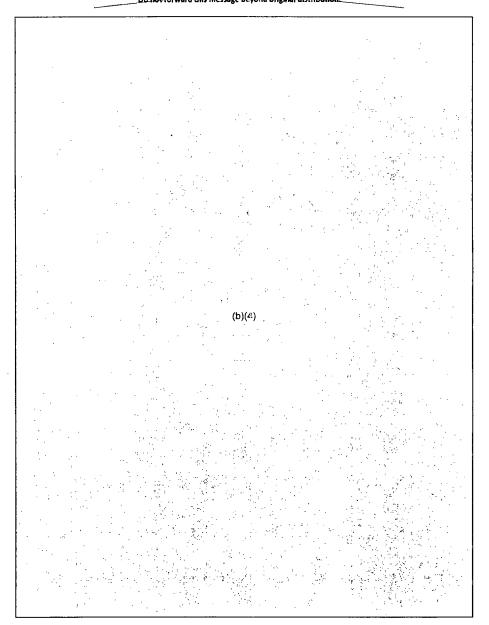
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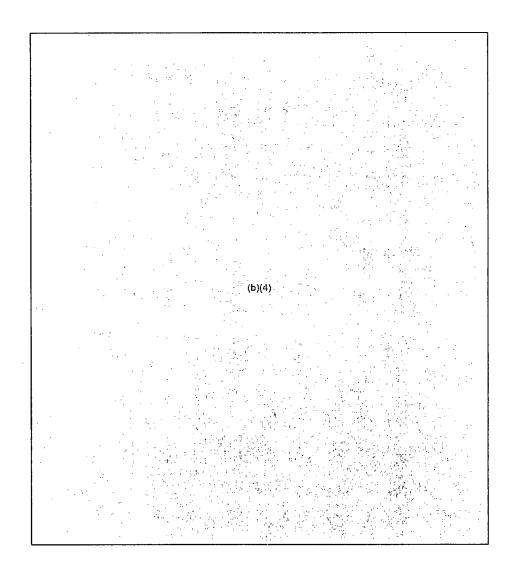
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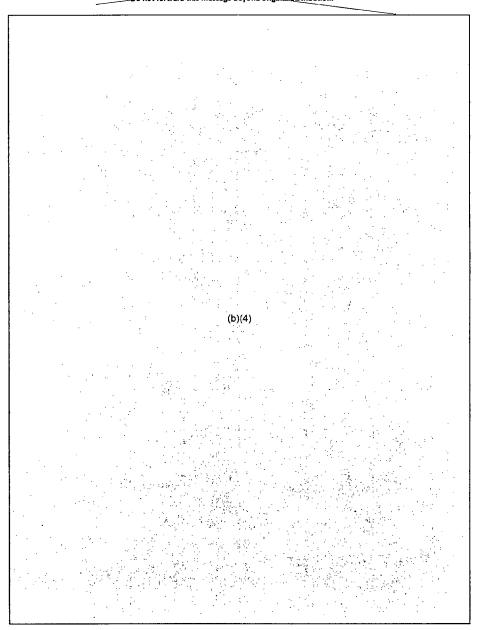
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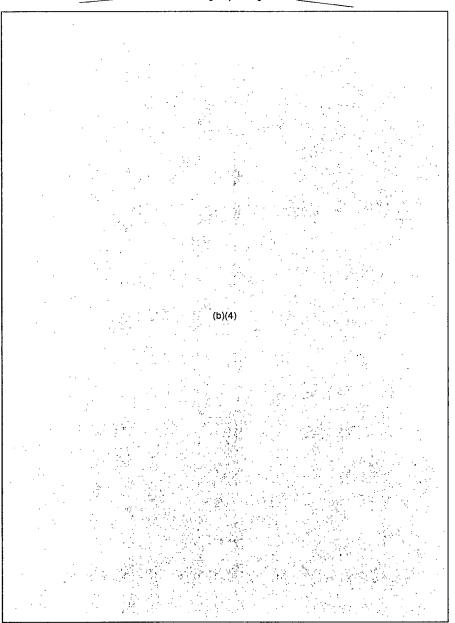
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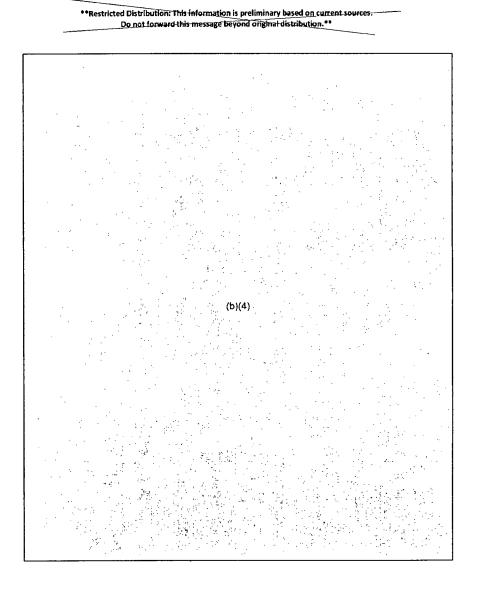


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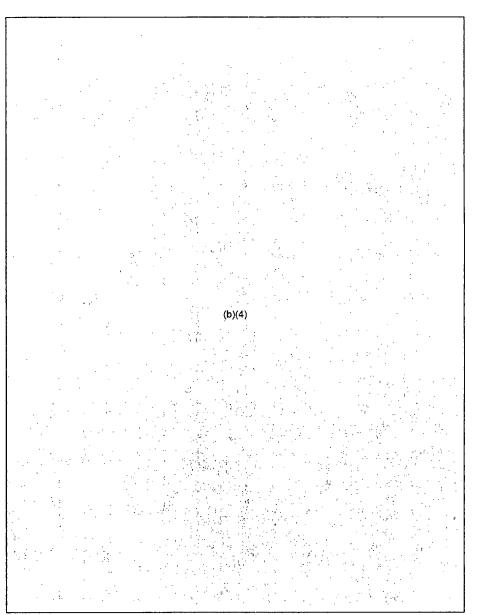


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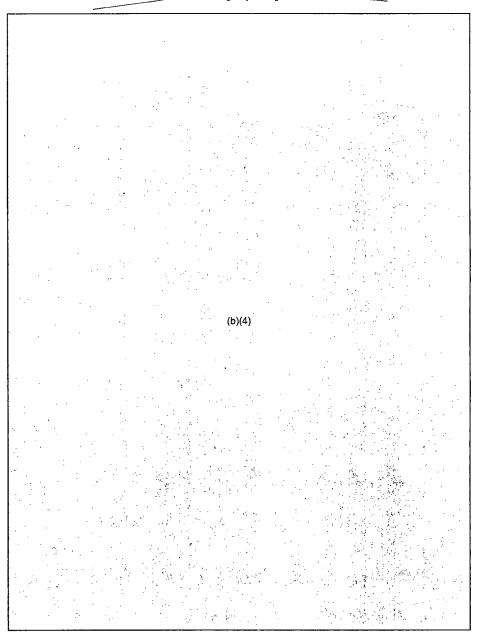
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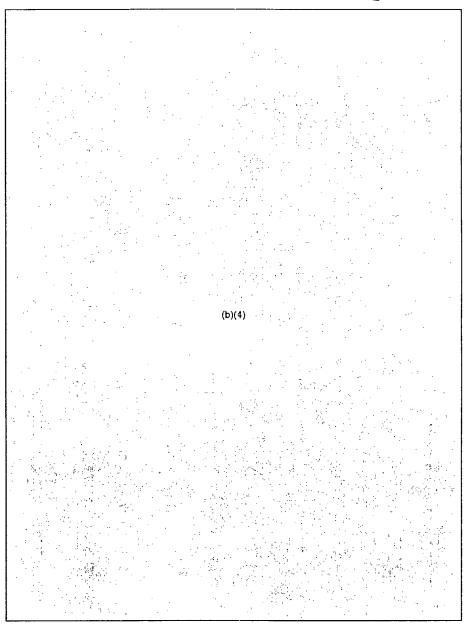
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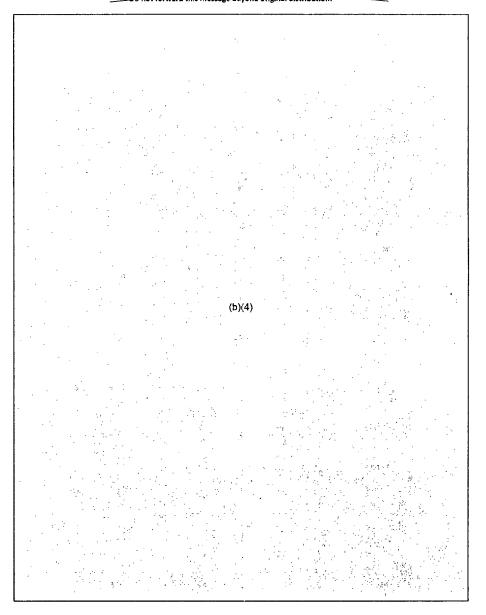


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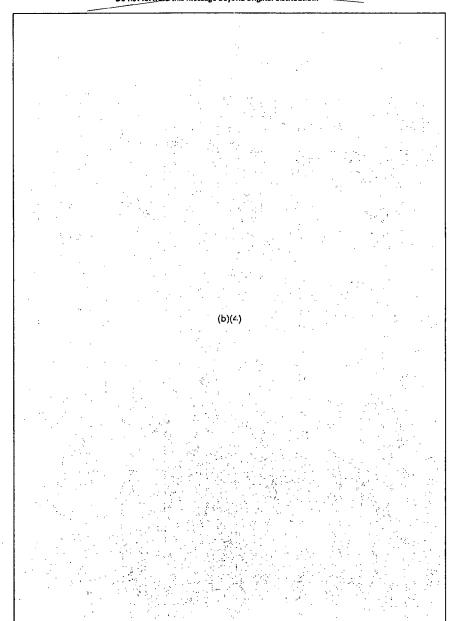


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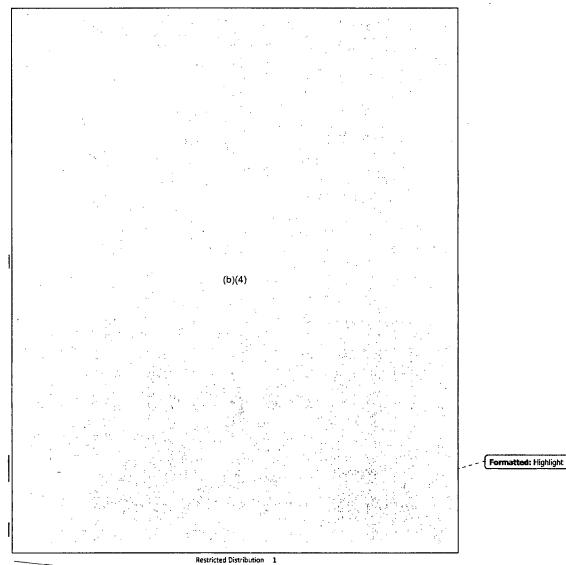
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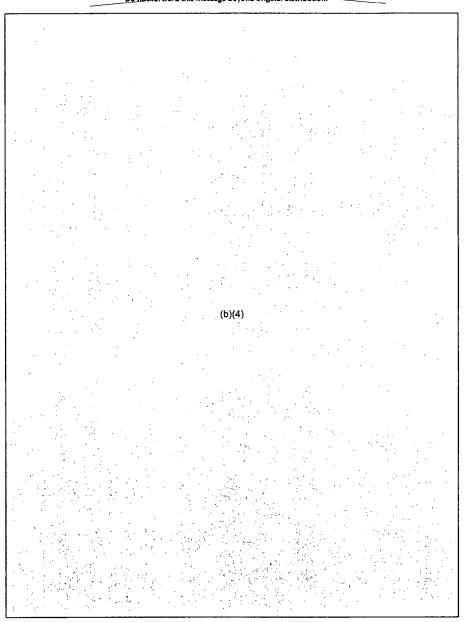
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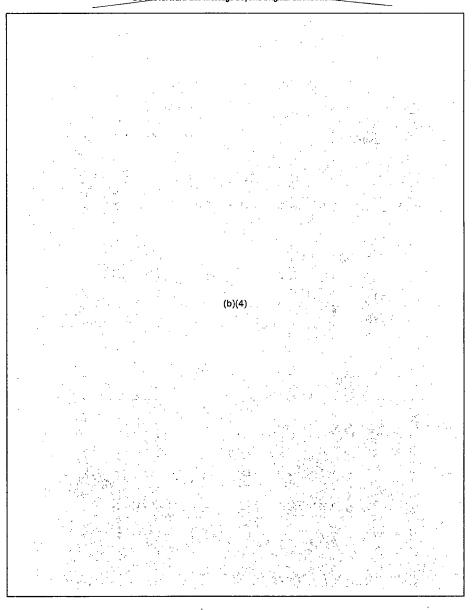
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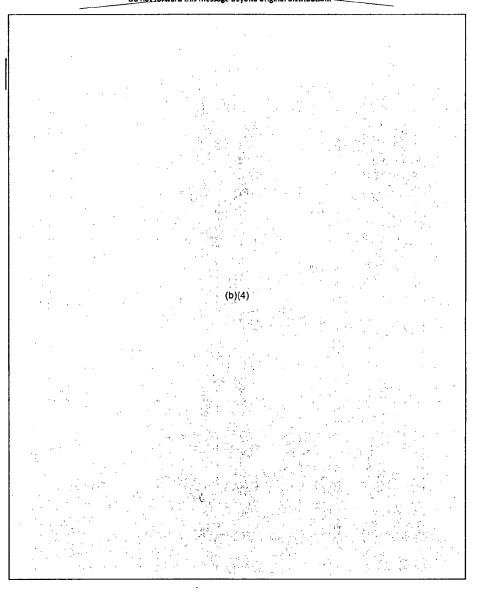
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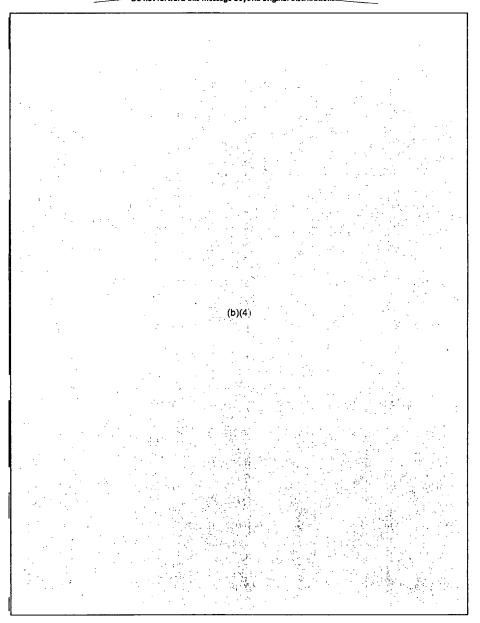
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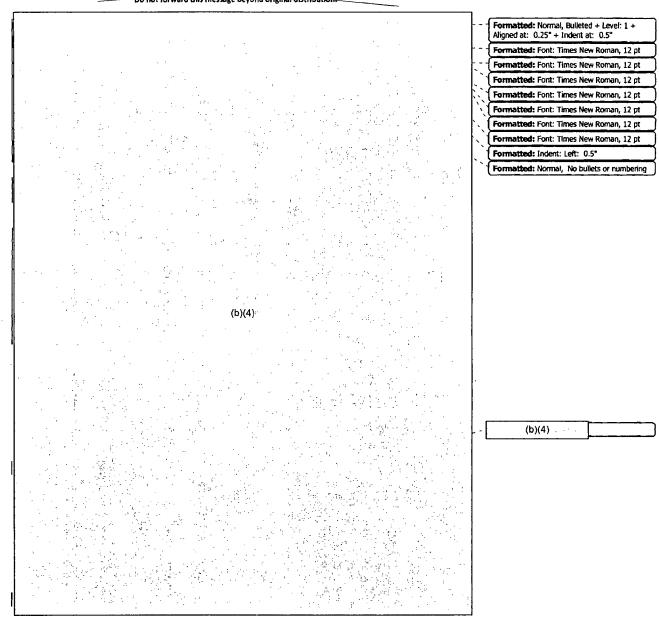


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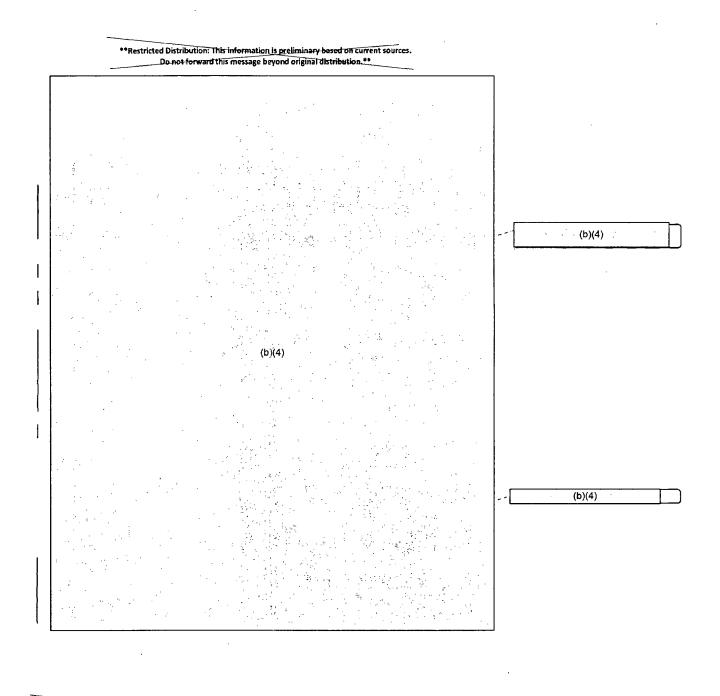
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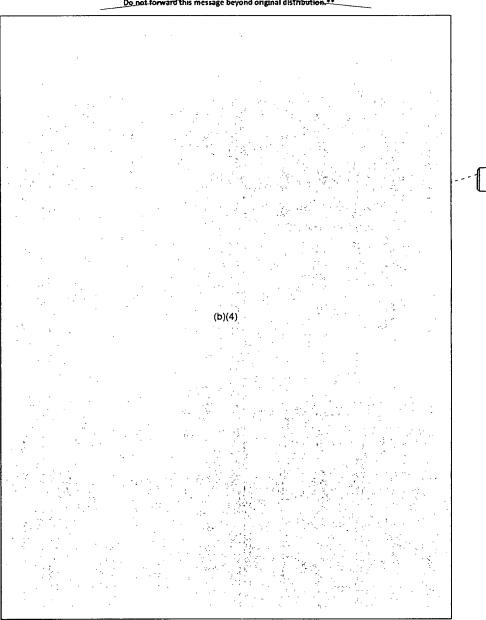
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EY 882 of 942

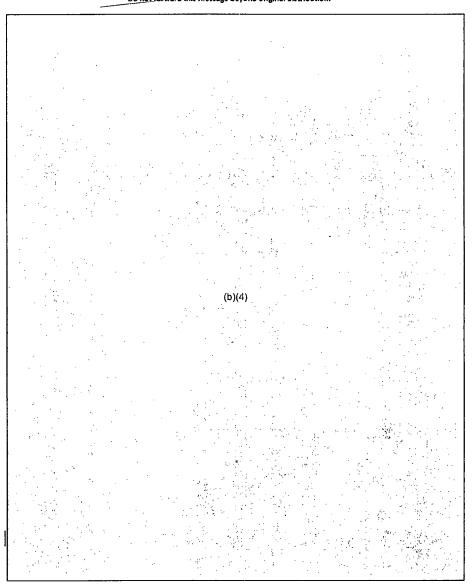


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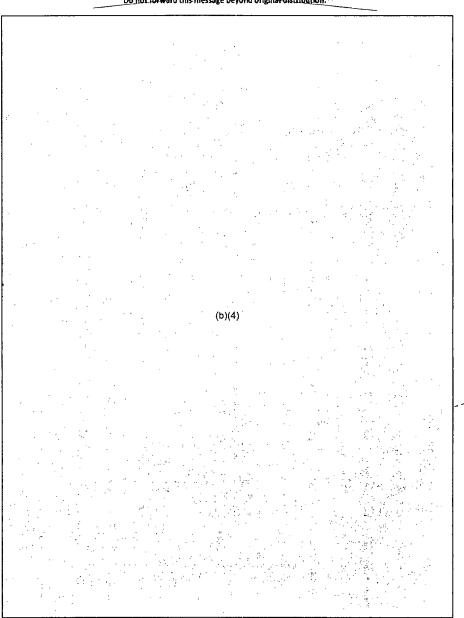
EY 883 of 942

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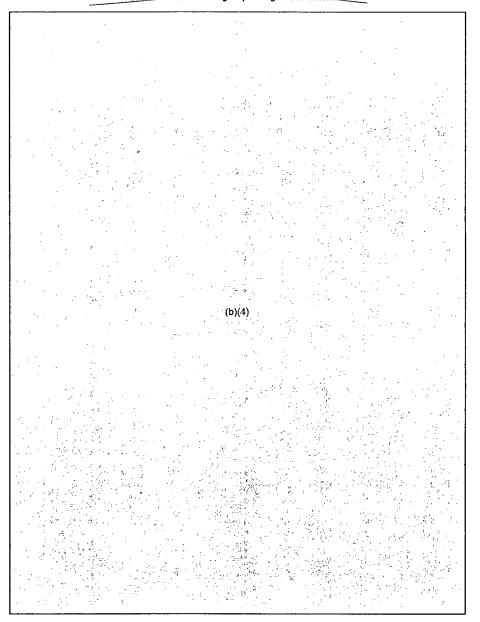


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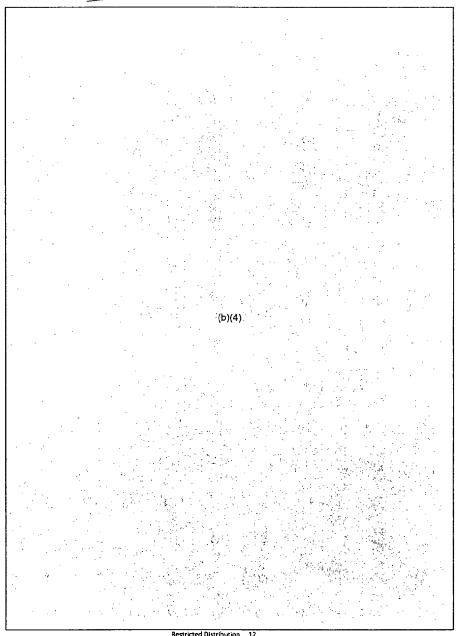
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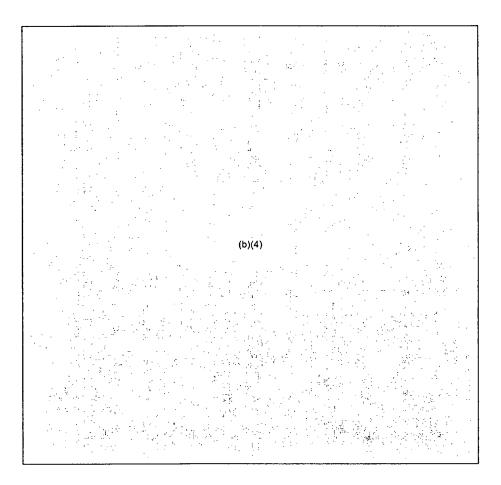
EY 886 of 942



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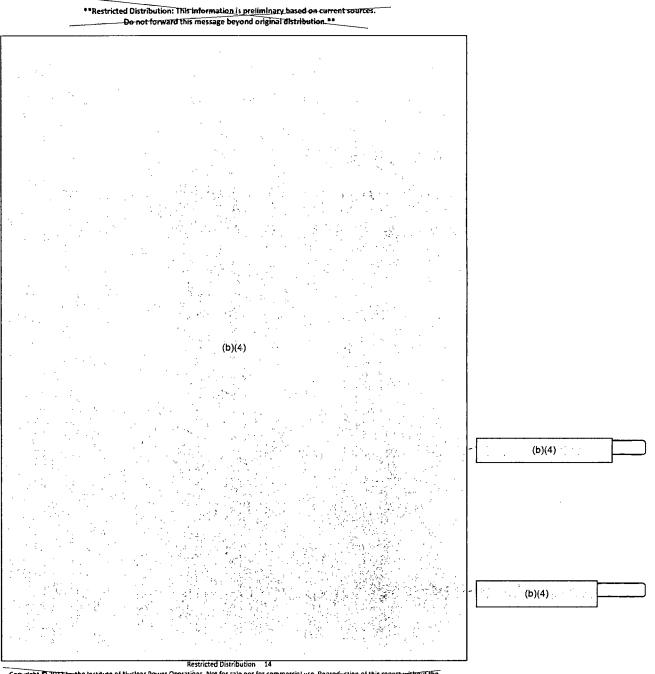
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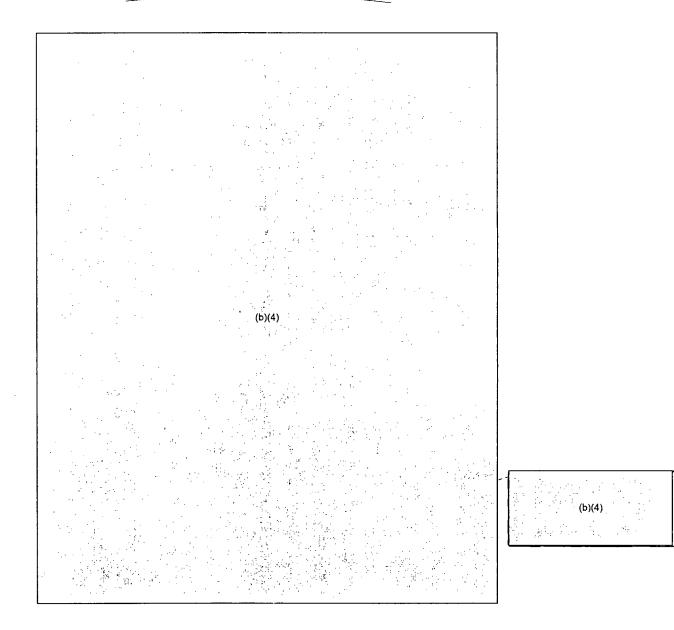
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EY 888 of 942



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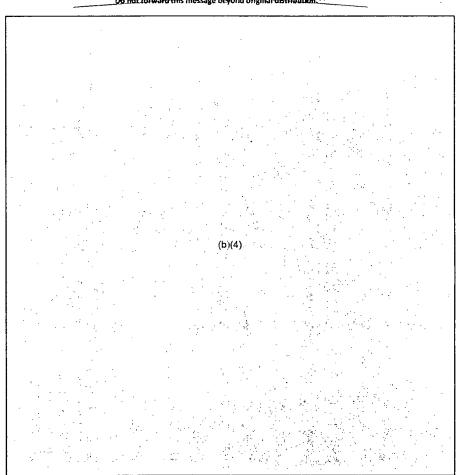
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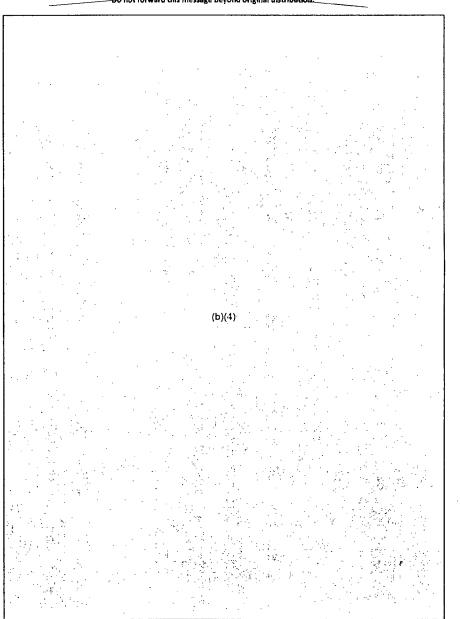
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EY 890 of 942



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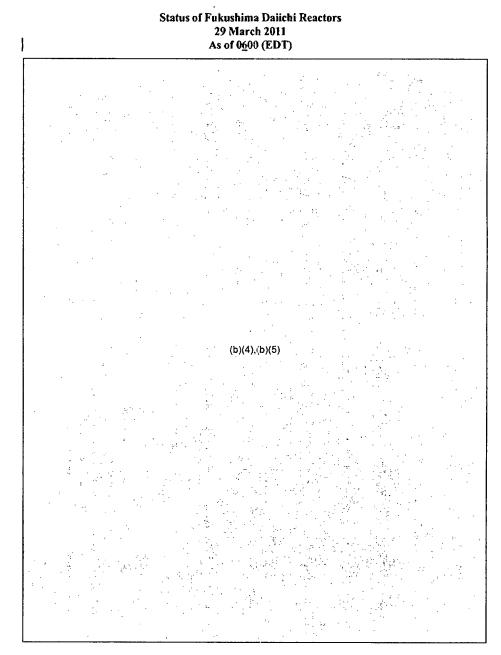
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## EY 892 of 942

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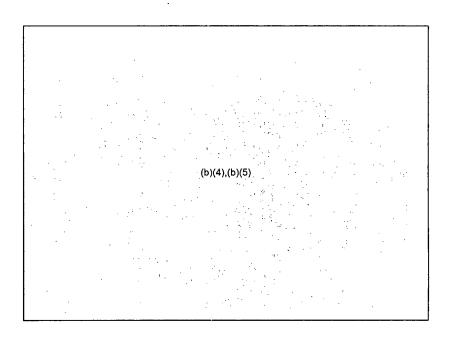
EY 893 of 942





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EY 894 of 942



 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.

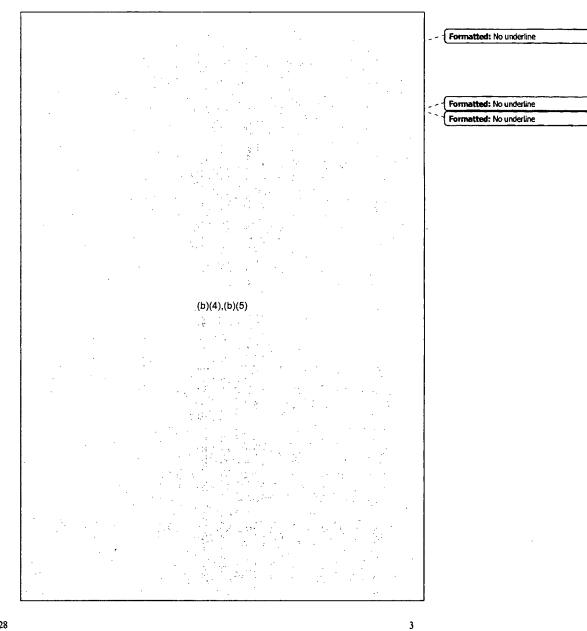
TEPCO says the trench extends 76 meters toward the sea but does not reach the sea, and that the contaminated water was not flowing into the sea.

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

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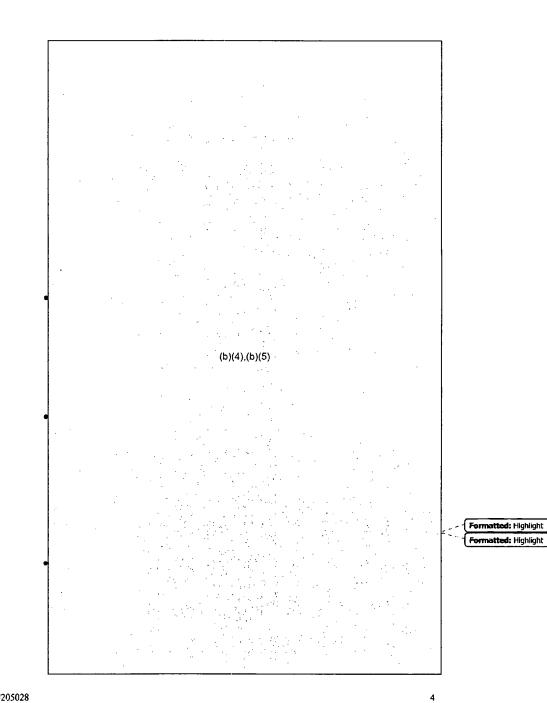


### reactor's trench because it was covered with debris.

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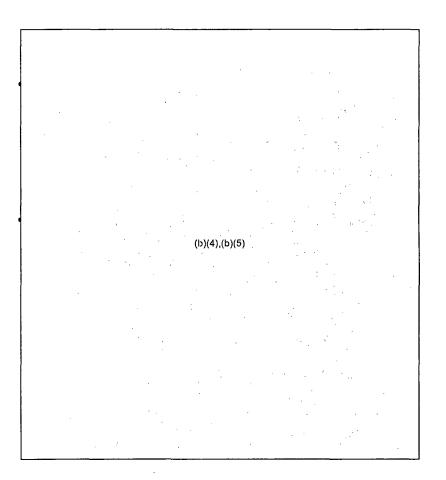
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EY 896 of 942



#205028

EY 897 of 942



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/

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EY 898 of 942

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http://www.mext.go.jp/english/ https://iportalwc.doe.gov/ http://www.nisa.meti.go.jp/english/ http://www.fepc.or.jp/english/

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Based on m	RST Assessment of Fukushima Daiichi Units, nost 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)
$\backslash$	(b)(4),(b)(5)
Core Cooling:	(b)(4),(b)(5) (b)(4),(b)(5) (b)(4),(b)(5) (b)(4),(b)(5)
Primary Containment:	No. 100 p5ia (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	:
the core is likel core spray noz.	that may have slumped to the bottom of the core and fuel in the lower region of y encased in salt and core flow is severely restricted and likely blocked. The zles are likely salted up restricting core spray flow. Injecting seawater through 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 ( $\underline{on-3/19}$ ) show entire fuel floor covered by grey-brown debris of building roof.

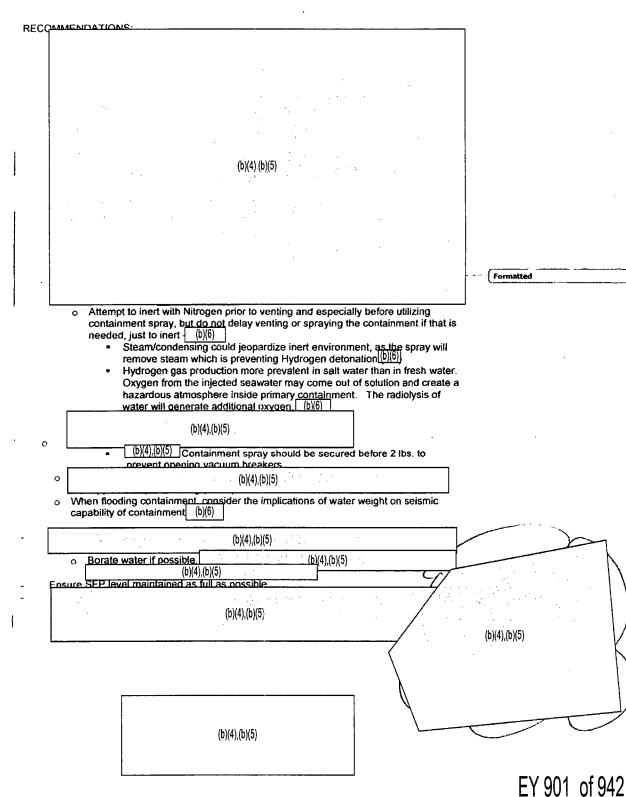
The primary containment is not damaged.

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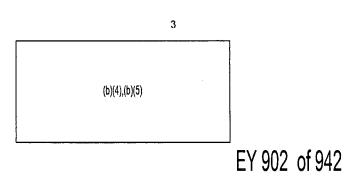
(b)(4),(b)(5)

EY 900 of 942

RST Assessment of Fukushima Dailchi 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



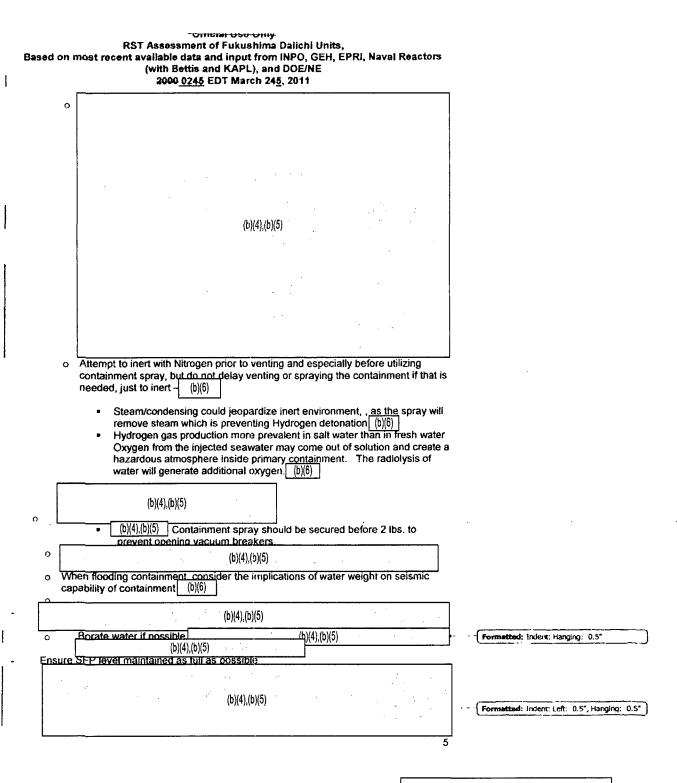
ł	Based	RST Assessment of Fukushima Daiichi Units, Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettls and KAPL), and DOE/NE 2000_0245 EDT March 245, 2011			
	0	(b)(4),(b)(5)			
_		D injection is desired for cooling directly to the core and for cooling material on			
		(b)(4),(b)(5)			



Based on mos	RST Assessment of Fukushima Dalichi Units, st recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE <u>2000_0245</u> EDT March 24 <u>5</u> , 2011
UNIT TWO	
STATUS: Core Statue	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)
	(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	
of the core less than b jeopardy c Injecting s past the fu region of t height, the recirculation be affecte environme determine	fuel may have slumped to the bottom of the core and fuel in the lower region a is likely encased in salt, however, the amount of salt build-up appears to be U-1, based on the reported lower temperatures. Core flow capability is in lue to continued salt build up. eawater through the RHR system is cooling the vessel, but with limited, flow tel. $(b)(4),(b)(5)$ water flow, if not blocked, should be filling the annulus he vessel to 2/3 core height. Based on the reports of RV level at one half core reactor vessel water level is believed to be even with the level of the on pump seals, implying the seals have failed. While core flow capability may d due to continued salt build up, RPV water level indication is suspect due to ent. Natural circulation believed impeded by core damage. It is difficult to how much cooling is getting to the fuel. Vessel temperature readings are al temperature which lags actual conditions.
recirculation There may	release path: fuel damaged, reactor coolant system potentially breached at on pump seals, primary containment damaged resulting in low level release, y be some scrubbing of the release if the release path is through the torus and I is maintained in the torus.
Fuel pool i	s heating up but is adequately cooled.
RECOMMENDAT	
-	(b)(4),(b)(5)

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



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

EY 904 of 942

Ba	-Official Oso Offiy- RST Assessment of Fukushima Daiichl Units, sed 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 <u>5</u> , 2011
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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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(b)(4),(b)(5)

EY 905 of 942

-VIIIGIAI USV UTIIV RST Assessment of Fukushima Dailchi 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: Damaged, fuel partially or fully exposed (JAIF, NISA, TEPCO) suspect Core Status 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 B1C (JAIF, NISA, TEPCO) Recirculation pump seals have likely failed. (b)(b) Expect to go freshwater cooling late on 3/25 Damage suspected suspected (JAIF, NISA, TEPCO) Not damaged Primary Containment (JAIF 22:00 3/24) Damaged (JAIF, NISA, TEPCO) Secondary Containment Spent Fuel Low water level (JAIF, NISA, TEPCO), pumping sea water into the SFP Pool 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:

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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.

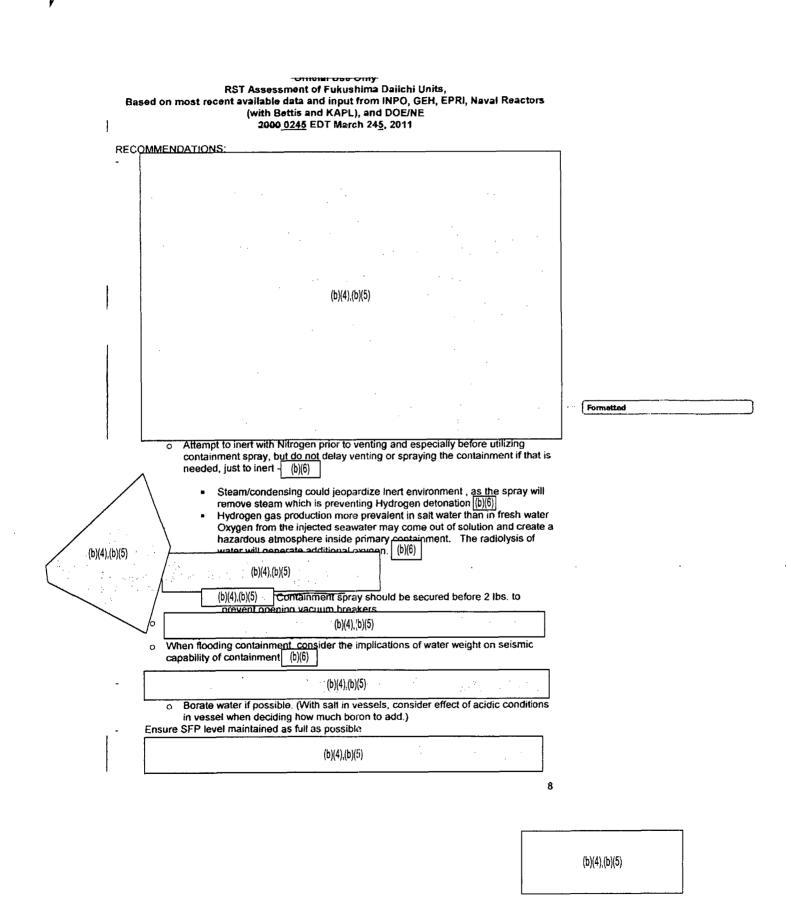
Injecting seawater through the RHR system is cooling the vessel, but with limited, flow past the fuel. (b)(4),(b)(5) water flow, if not blocked, should be filling the annulus region of the vessel to 2/3 core height. Based on the reports of RV level at one half core height, the reactor vessel water level 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 TEPCeQ 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).

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



EY 907 of 942

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

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GEH : NO Markups 3-25-11

EY 908 of 942

#### Official Use Only-RST Assessment of Fukushima Dalichi Units, Based on most recent available data and input from INPO, GEH, EPRI, Navel Reactors (with Bettis and KAPL), and DOE/NE 2000\_0245 EDT March 245, 2011

#### UNIT FOUR

Offloaded 105 days at time at accident (JAIF, NISA, TEPCO)		
Not necessary (JAIF, NISA, TEPCO)		
Not applicable (JAIF, NISA, TEPCO)		
Severely damaged, hydrogen explosion. (JAIF, NISA, TEPCO)		
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		
0/24		
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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### UNIT FIVE

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#### 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 Fuet 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)

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#### ASSESSMENT:

Unit five is relatively stable

#### **RECOMMENDATIONS:**

Finish repairs on RHR pump used for fuel pool cooling.

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#### Monitor

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

EY 910 of 942

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## UNIT SIX

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#### 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)

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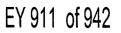
#### ASSESSMENT:

Unit Six is relatively stable

# **RECOMMENDATIONS:**

- Monitor

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



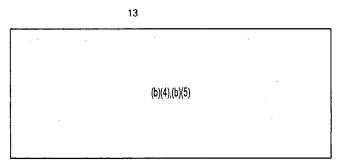
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#### ABBREVIATIONS:

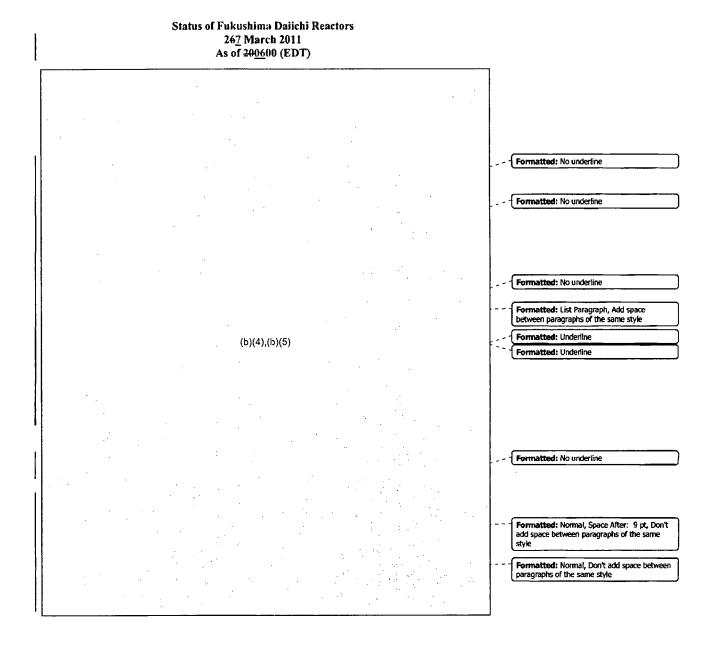
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GEH - (b)(4),(b)(5)	(b)(4),(b)(5)
INPO - Institute of Nuclear F	owe

INPO – Institute of Nuclear Powel – John Stranger, JAIF – Japan Atomic Industrial Forum NISA - Nuclear and Industrial Safety Agency TEPCO – Tokyo Electric Power Company



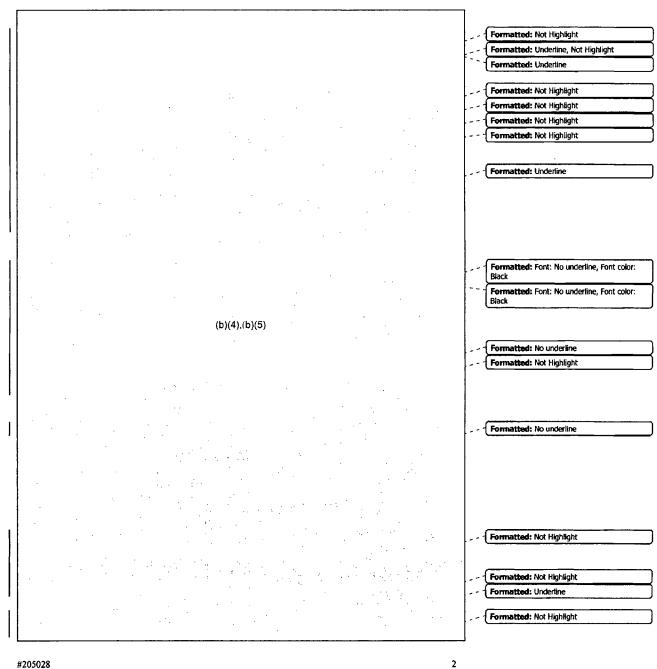
EY 912 of 942





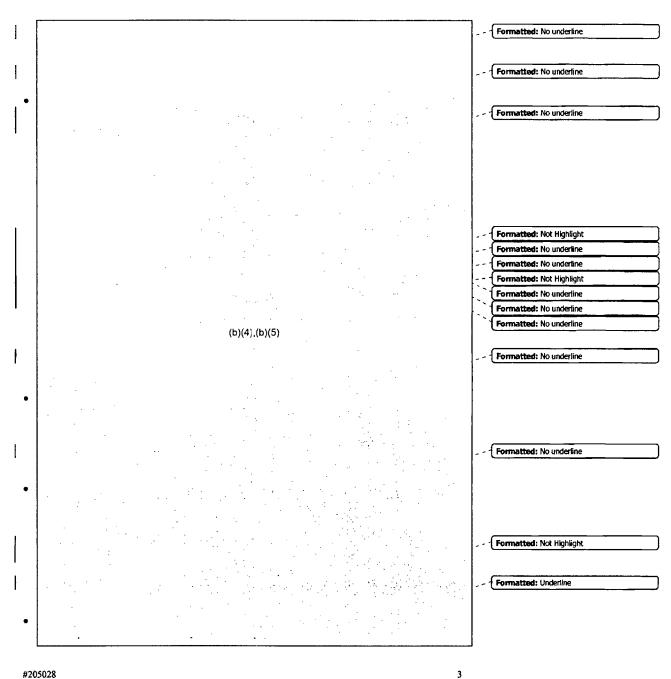
EY 913 of 942

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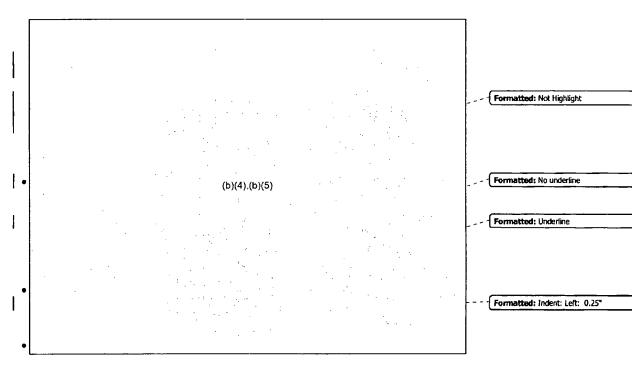
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EY 914 of 942



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EY 915 of 942



#### Sources include: Federation of Electric Power Companies of Japan Nuclear Industrial Safety Agency Links:

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EY 916 of 942

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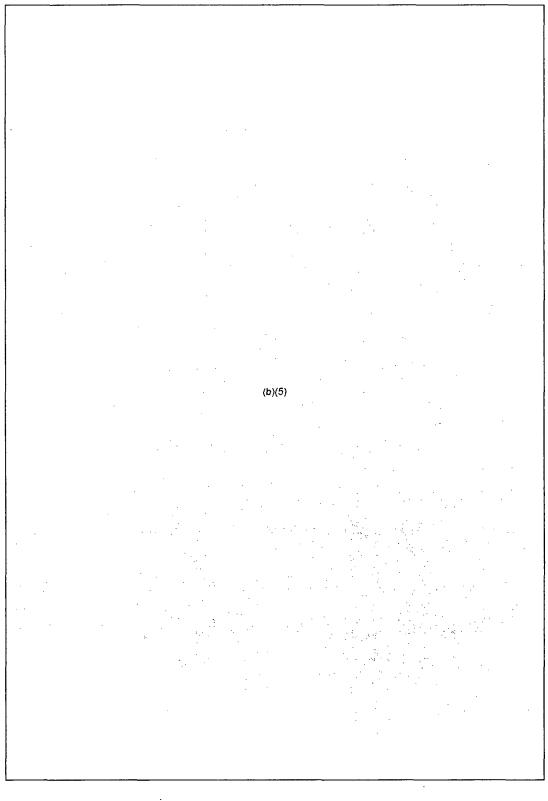
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EY 917 of 942

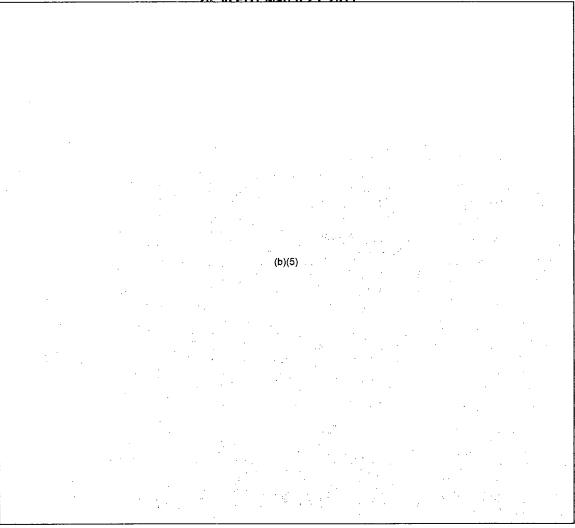


# -Official Use Only-RST Response to Questions from Japan Team 20:30 EDT March 25, 2011

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Page 1

EY 918 of 942



Official Use Only RST Response to Questions from Japan Team 20:30 EDT March 25, 2011

EY 919 of 942

## UNIT ONE

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

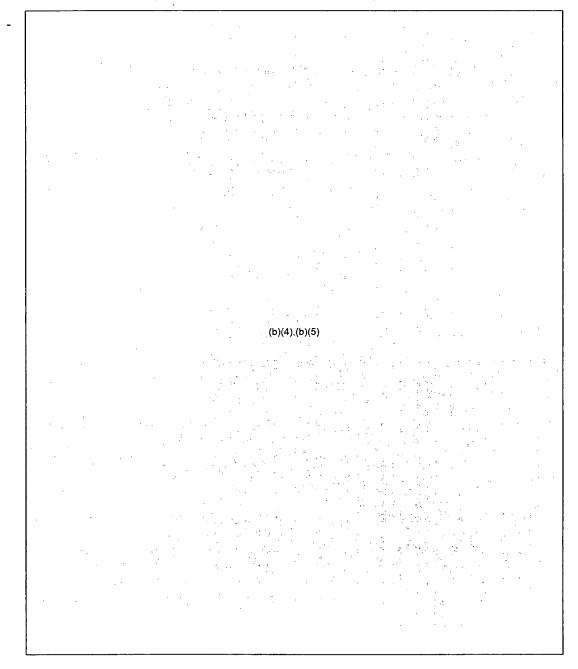
Core Status:	<ul> <li>Core is contained in the reactor pressure vessel, reactor water level is unkn The volume of sea water injected to cool the core has left enough salt to fill lower plenum to the core plate (GEH, INPO, Bettis, KAPL).</li> <li>Vessel temperatures 149C at bottom drain, 197C at FW nozzle (NISA 1800 JDT 3/25)</li> <li>RPV at 65.7 psia (increasing trend), DW and torus pressure at 40 psia (decreasing trend) (NISA 1800 JDT 3/25).</li> </ul>	
Core Cooling:	Currently fresh water injection with no boron, injecting through feedwater 120 I/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	Not damaged, 40 psia (b)(4),(b)(5)	
Containment:	(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)	
	(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)**



EY 921 of 942

# (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

#### -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 0600 EDT March 26, 2011

The purpose of this occurrent 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 I/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.

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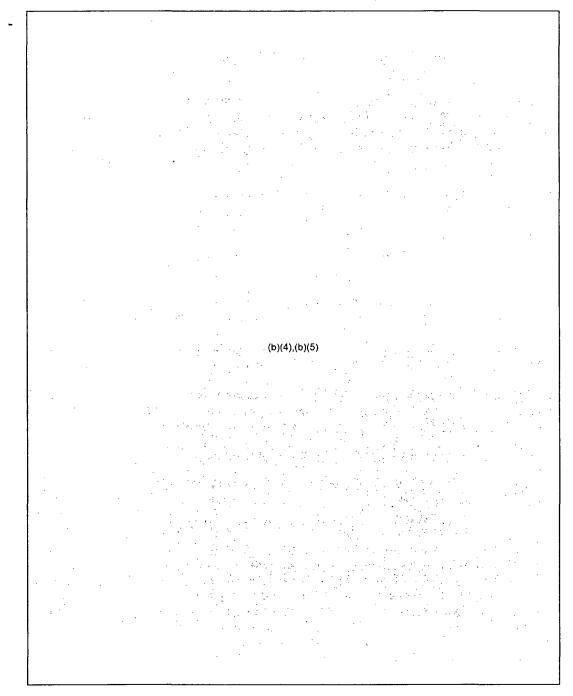
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The fuel pool is slowly heating and has not reached saturation. Overhead photos ( $\frac{\text{on}-3/19}{\text{on}}$ ) show entire fuel floor covered by grey-brown debris of building roof.

The primary containment is not damaged.

# **RECOMMENDATIONS: (for consideration to stabilize Unit 1)**



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- 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
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# 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.

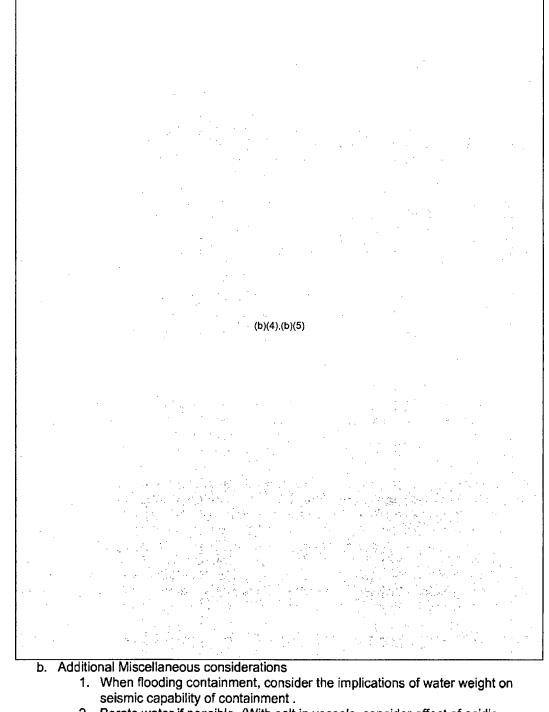
Fuel pool is heating up but is adequately cooled.

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# **RECOMMENDATIONS: (for consideration to stabilize Unit 2)**



- 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:

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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.

- HPCI suction pressure
   Drywell instrument taps
   Radiation monitoring instruments

6 EY 928 of 942

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# UNIT THREE

#### STATUS:

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

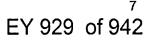
# ASSESSMENT:

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 buildozed 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

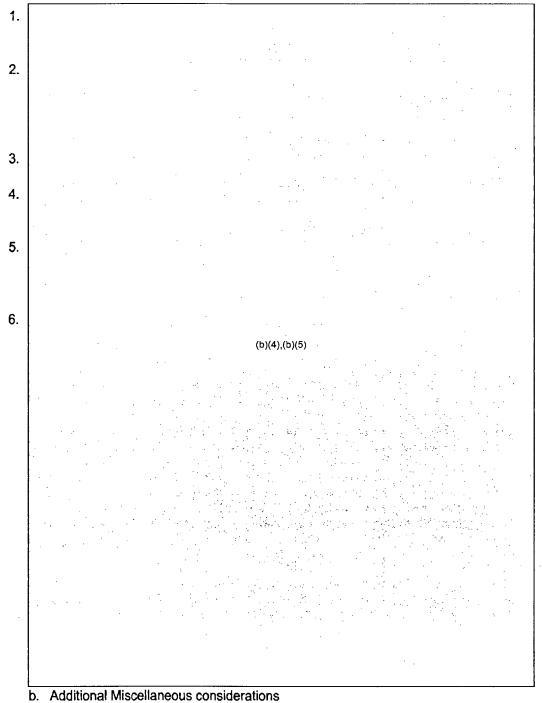


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RST Assessment of Fukushima Daiichi Units, Based on most recent available data and input from INPO, GEH, EPRI, Naval Reactors (with Bettis and KAPL), and DOE/NE 0600 EDT March 26, 2011

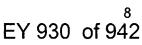
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(TEPCO sample table – 3/25/11). Several possible sources (MSIV leakage, FW check valves, Rx building sump drains) were identified, however the likely source is the fire water spray onto the reactor building. Additional evaluation is needed.



**RECOMMENDATIONS: (for consideration to stabilize Unit 1)** 

1. When flooding containment, consider the implications of water weight on seismic capability of containment.



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- 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
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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)
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 buildozed 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.

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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

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#### **RECOMMENDATIONS:**

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# **ABBREVIATIONS:**

GEH - General Electric Hitachi

INPO - Institute of Nuclear Power Operations

JAIF - Japan Atomic Industrial Forum

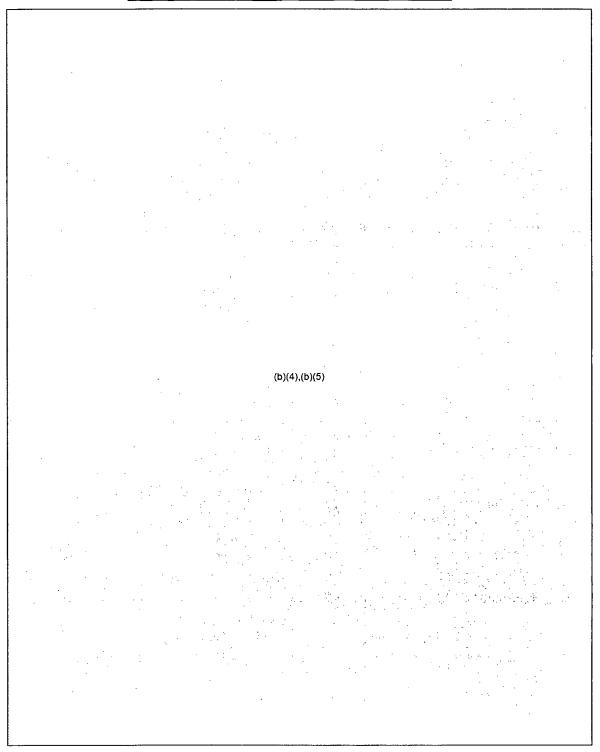
NISA - Nuclear and Industrial Safety Agency

TEPCO - Tokyo Electric Power Company

EY 935 of 942

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# Additional Measures in Light of TEPCO Current Strategy

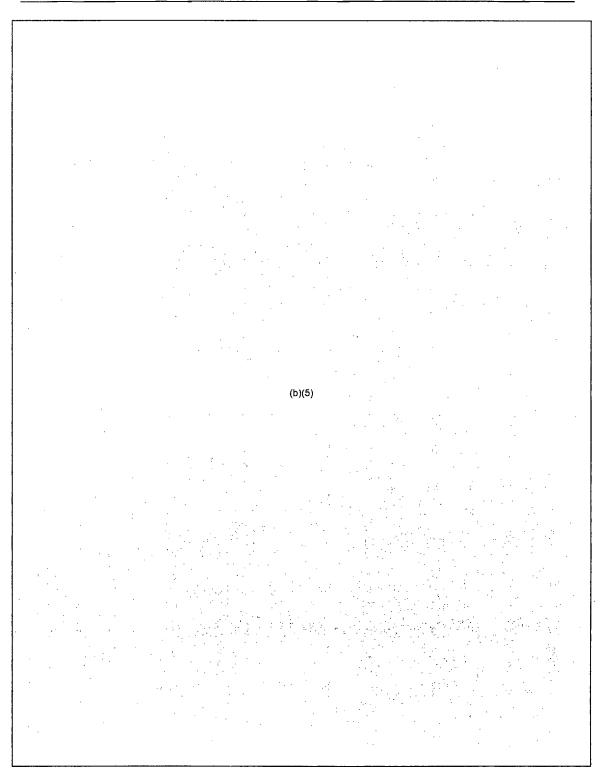
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- 1 --OFFICIAL USE ONLY

2100 EDT Saturday, April 09, 2011 EY 936 of 942

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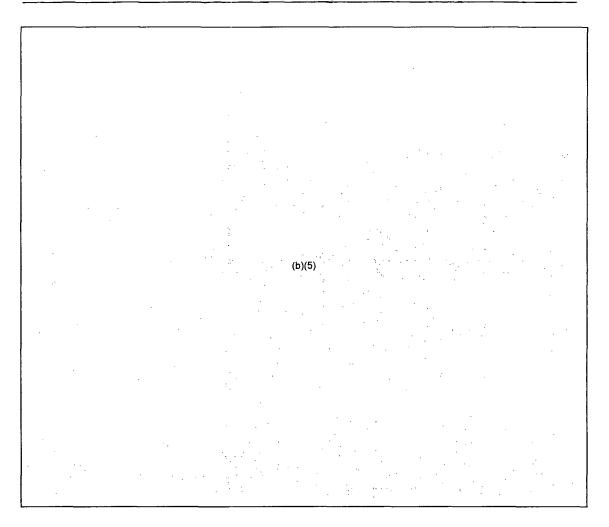
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EY 937 of 942

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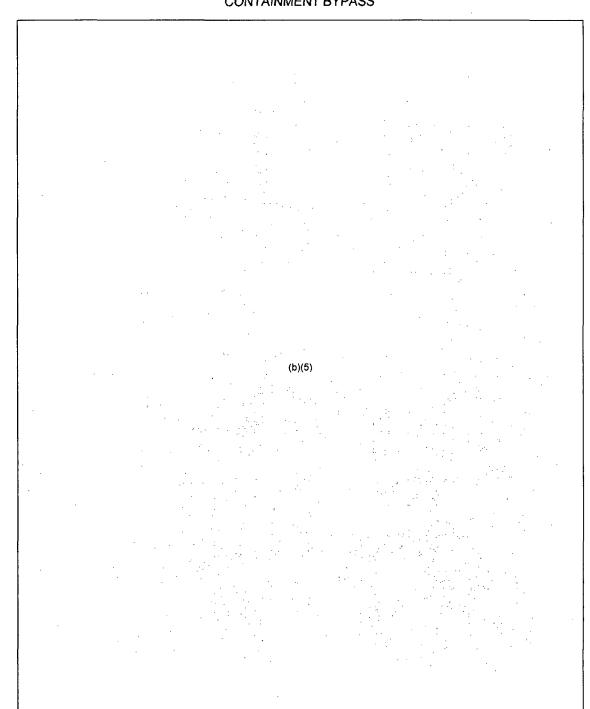
2100 EDT Saturday, April 09, 2011

EY 938 of 942

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# **ENCLOSURE 1**



CONTAINMENT BYPASS

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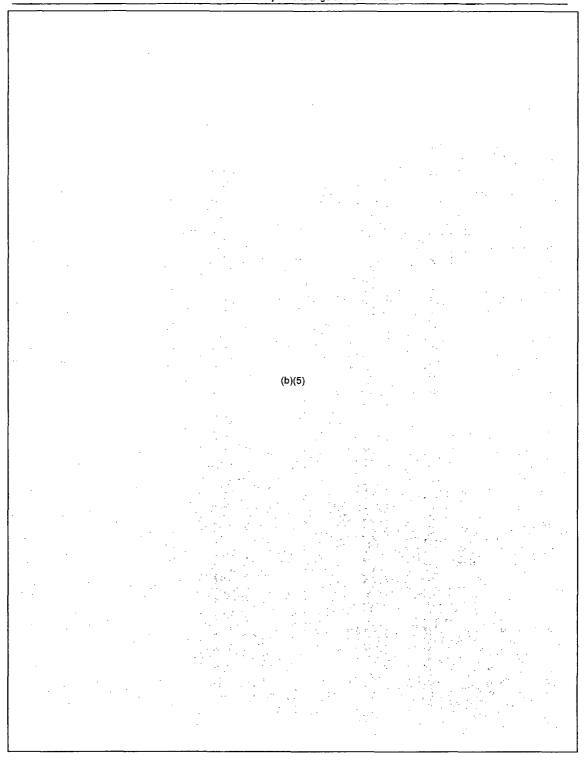
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EY 939 of 942

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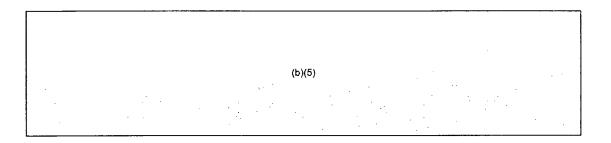
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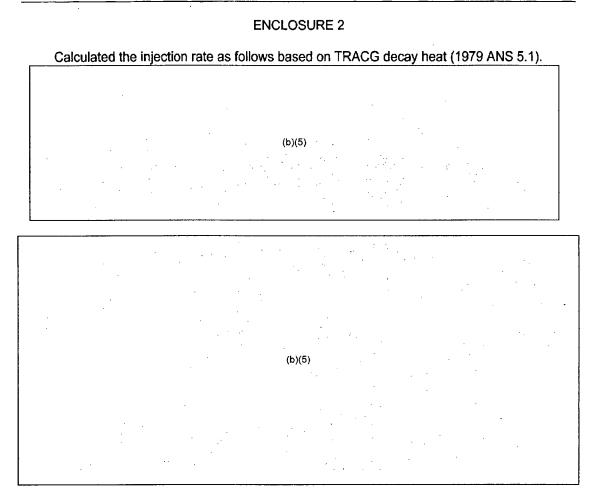
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- 6 -

2100 EDT Saturday, April 09, 2011 EY 941 of 942

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Issued Rev. 2

EY 942 of 942

- 7 -

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