UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 21, 2015

Mr. Bryan C. Hanson
President and Chief Nuclear Officer
Exelon Generation
4300 Winfield Rd
Warrenville, IL 60555

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – SUPPLEMENT TO STAFF ASSESSMENT OF RESPONSE TO 10 CFR 50.54(f) INFORMATION REQUEST – FLOOD-CAUSING MECHANISM REEVALUATION (TAC NOS. MF3097 AND MF3098)

Dear Mr. Hanson:

The purpose of this letter is to transmit a supplement to the U.S. Nuclear Regulatory Commission (NRC) staff's assessment for Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs) reevaluated flood hazard information that was issued to you by letter dated April 16, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15077A103). The supplement updates the original staff assessment to address changes in the NRC's approach to the steps following the review of the flood hazard reevaluations as directed by the Commission. The letter also addresses the next steps associated with the mitigation strategies assessment with respect to the reevaluated flood hazards.

By letter dated March 12, 2012 (ADAMS Accession No. ML12053A340), the NRC issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The request was issued as part of implementing lessons learned from the accident at the Fukushima Dai-ichi nuclear power plant. Enclosure 2 to the 50.54(f) letter requested licensees to reevaluate flood-causing mechanisms using present-day methodologies and guidance. By letter dated March 12, 2013 (ADAMS Accession No. ML13078A010), Calvert Cliffs Nuclear Power Plant, LLC (the licensee), previously as Constellation Energy Group, LLC, responded to this request for Calvert Cliffs. This response was supplemented by letters dated February 10, 2014 (ADAMS Accession No. ML14052A052), and March 7, 2014 (ADAMS Accession No. ML14162A261). By letter dated April 16, 2015, the NRC staff transmitted to the licensee a staff assessment of the information provided in the aforementioned letters. The NRC staff has completed its review of the information provided as documented in the staff assessment and the enclosed supplement to the staff assessment. This closes out the NRC's efforts associated with TAC Nos. MF3097 and MF3098.

The enclosed supplement to the NRC staff assessment updates the staff's conclusions in accordance with the flood hazard reevaluation approach described in NRC letter dated September 1, 2015 (ADAMS Accession No. ML15174A257), concerning the coordination of requests for information regarding flooding hazard reevaluations and mitigating strategies for beyond-design-basis external events. This letter describes the changes in the NRC's approach to the flood hazard reevaluations that were approved by the Commission in its Staff Requirements Memorandum (ADAMS Accession No. ML15209A682) to

COMSECY-15-0019 (ADAMS Accession No. ML15153A104) that described the NRC's mitigating strategies and flooding hazard reevaluation action plan.

As documented in the NRC staff assessment and the enclosed supplement, the staff has concluded that the licensee's reevaluated flood hazard information is suitable for the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and staff) for Calvert Cliffs. Further, the licensee's reevaluated flood hazard information is suitable for other assessments associated with Near-Term Task Force Recommendation 2.1 "Flooding".

The reevaluated flood hazard results for local intense precipitation and storm surge were not bounded by the current design-basis flood hazard. In order to complete its response to Enclosure 2 to the 50.54(f) letter, the licensee is expected to submit a revised integrated assessment or a focused evaluation, as appropriate, to address these reevaluated flood hazards, as described in the NRC's September 1, 2015, letter.

If you have any questions, please contact me at (301) 415-6197 or email at Tekia.Govan@nrc.gov.

Sincerely,

Tekia V. Govan

Tekia Govan, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318

Enclosure:
Supplement to Staff Assessment of Flood Hazard Reevaluation Report

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SUPPLEMENT TO

STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO FLOODING HAZARD REEVALUATION REPORT

NEAR-TERM TASK FORCE RECOMMENDATION 2.1

RELATED TO THE FUKUSHIMA DAI-ICHI NUCLEAR POWER PLANT ACCIDENT

CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKETS NO. 50-317 AND 50-318

## 1.0 INTRODUCTION

This document is a supplement to the U.S. Nuclear Regulatory Commission (NRC) staff assessment that was transmitted by letter dated April 16, 2015 (NRC, 2015a), to Calvert Cliffs Nuclear Power Plant, LLC (the licensee), previously known as the Constellation Energy Group, LLC (CENG), for Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs). With the exceptions of Table 3.1-2 and the Reference section, this supplement only contains the sections that were changed to resolve the open item and reflect the changes in the NRC's approach to the flood hazard reevaluations that were approved by the Commission in its Staff Requirements Memorandum (NRC, 2015b) to COMSECY-15-0019 (NRC, 2015c), which described the NRC's mitigating strategies and flooding hazard reevaluation action plan. Table 3.1-2 at the end of the supplement is copied from the staff assessment for convenience. Instead of repeating the Reference section in its entirety, only the additions to the list of references are included in the supplement.

## 2.0 REGULATORY BACKGROUND

There are no changes or updates to this section of the NRC staff assessment.

## 3.0 TECHNICAL EVALUATION

### 3.1 Site Information

There are no changes or updates to this section of the NRC staff assessment.

### 3.2 Local Intense precipitation (LIP) and Associated Site Drainage

#### 3.2.1 LIP Depth, Duration, and Loading Analysis

Tables 3.2-1 and 3.2-2 provide the probable maximum precipitation (PMP) inputs and depths supplied by the licensee in the Flooding Hazard Reevaluation Report (FHRR). Section 2.1.2 of the FHRR stated that a review of historical precipitation records for Maryland and Virginia since the publication of National Oceanic and Atmospheric Administration (NOAA) Hydrometeorological Reports (HMR) Nos. 51 (Schreiner and Riedel, 1978) and 52 (Hansen,

Schreiner, and Miller, 1982) identified no events approaching or exceeding the PMP provided therein. The NRC staff reviewed that information and found that the licensee's conclusions are reasonable.

The NRC staff notes that a reasonable estimate of the site's LIP PMP is the application of an appropriate NOAA HMR estimate for any rainfall duration used in NUREG/CR-7046, regardless of temporal distribution of the rainfall. The licensee obtained 1-sq. mile PMP depths for durations ranging between 5-minutes and 6-hours using HMR-51 and HMR-52. Therefore, the NRC staff confirmed that the licensee selected appropriate rainfall rate values to satisfy the 50.54(f) information request.

The PMP depths shown in Table 3.2-2 were temporally distributed by the licensee using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) Meteorological Model module (USACE, 2010). The HEC-HMS frequency storm option of the Meteorological Model was used to develop a 6-hour PMP storm event (CENG, 2013a, Section 2.1.2).

3.2.2 Runoff Analyses

The licensee used the HEC-HMS software to evaluate runoff and hydrologic routing for each of the six subbasins. Figure 3.2-1 shows the subbasins, and Figure 3.2-2 shows the node-link (subbasin-junction) schematic of the subbasins, as represented throughout the HEC-HMS analysis. The subbasins were assumed to be nearly impervious, with a runoff curve number of 98. The times of concentration for the subbasins were estimated using Natural Resources Conservation Service (NRCS) methodologies. The subbasin peak discharges were estimated using the HEC-HMS NRCS dimensionless unit hydrograph option. Table 3.2-1 presents the drainage area and time of concentration for each subbasin.

The FHRR stated that the HEC-HMS model incorporates topographic information used to support the final safety assessment report for the combined license application (COL) for Calvert Cliffs, Unit 3 (Unistar, 2012). The stormwater runoff from Subbasins 1, 2, and 3 combine at Junction J-2 near the southern corner of the powerblock, where the flow is diverted into two downstream flow paths, Reaches R-2 and R-3, which direct flow around the powerblock. Reaches R-1 and R-2 also are identified as Downstream 1 and 2 reaches, which flow to the southeast and southwest of the powerblock, respectively (see Figure 3.2-2). These downstream reaches discharge into the Chesapeake Bay at Outlet 1 and 2. Runoff from Subbasin 5 is routed through Outlet 1. Runoff from Subbasins 4 and 6 are routed through Outlet 2. Small storm drainage ditches and culverts are assumed to not function for the purposes of the PMF calculations. The licensee's results from the HEC-HMS analysis are summarized in Table 3.2-3. The NRC staff's review confirms that the licensee-estimated peak discharges correspond with the contributing area. The NRC staff's review also confirms that the reevaluated hazard is not bounded by the current design-basis (CDB).

The NRC staff requested through a request for additional information (RAI), electronic versions of the HEC-HMS model input files used in the LIP analyses (NRC, 2014a). In its March 7, 2014, response, the licensee provided the requested files for staff's review (CENG, 2014c). After reviewing the information provided, the staff determines that the effect of uncertainty in the subbasin slope had not been sufficiently addressed by the licensee. The NRC staff determines

that this uncertainty could have a potentially significant impact on the PMP runoff lag time and the peak LIP flow rates. The NRC staff further determines that the sheet flow characteristic length, blockage and conservatism of vehicle barriers, and roof drainage partitioning were not discussed. The NRC staff conducted additional sensitivity analyses, and also reviewed the LIP characterization, as well as model boundary and initial conditions.

The NRC staff conducted limited sensitivity analyses of these parameters, and also reviewed the LIP characterization, as well as model boundary and initial conditions. The NRC staff altered the site parameters that were used to estimate the timing of the LIP runoff and evaluated that sensitivity of the model results. The NRC staff determines that no significant change in the licensee's conclusion would be likely given reasonable additional conservatisms in parameter selections.

### 3.2.3 Water Level Determination

There are no changes or updates to this section of the NRC staff assessment.

### 3.2.4 Staff Conclusion

The NRC staff confirms the licensee's conclusion that the reevaluated flood hazard for LIP and associated site drainage is not bounded by the current design-basis flood hazard. Therefore, the licensee is expected to submit a focused evaluation for LIP and associated site drainage consistent with the process outlined in COMSECY-15-0019 (NRC, 2015c) and associated guidance that will be issued. Under this approach, the NRC staff anticipates that licensees will perform and document a focused evaluation for LIP and associated site drainage that evaluates the impact of the LIP hazard on the site and implements any necessary programmatic, procedural or plant modifications to address this hazard exceedance. The NRC staff anticipates that licensees will submit letters providing a summary of the evaluation and, if needed, regulatory commitments to implement and maintain appropriate programmatic, procedural or plant modifications to protect against the LIP hazard.

## 3.3 Streams and Rivers

There are no changes or updates to this section of the NRC staff assessment.

## 3.4 Failure of Dams and Onsite Water Control/Storage Structures

There are no changes or updates to this section of the NRC staff assessment.

## 3.5 Storm Surge

There are no changes or updates to this section of the NRC staff assessment.

### 3.5.1 Summary of Previous Evaluations

There are no changes or updates to this section of the NRC staff assessment.

3.5.2 FHRR Probable Maximum Storm Surge Evaluations

There are no changes or updates to this section of the NRC staff assessment.

3.5.3 FHRR Storm Surge Results

There are no changes or updates to this section of the NRC staff assessment.

3.5.4 Staff Conclusion

The NRC staff confirmed the licensee's conclusion that the reevaluated hazard of flooding from storm surge is not bounded by the current design-basis flood hazard. Therefore, the licensee is expected to submit a focused evaluation confirming the capability of flood protection and available physical margin or a revised integrated assessment consistent with the process and guidance discussed in
COMSECY-150019 (NRC, 2015c).

3.6 Seiche

There are no changes or updates to this section of the NRC staff assessment.

3.7 Tsunami

There are no changes or updates to this section of the NRC staff assessment.

3.8 Ice-Induced Flooding

There are no changes or updates to this section of the NRC staff assessment.

3.9 Channel Migrations or Diversions

There are no changes or updates to this section of the NRC staff assessment.

## 4.0 REEVALUATED FLOOD HEIGHT, EVENT DURATION AND ASSOCIATED EFFECTS FOR HAZARDS NOT BOUNDED BY THE CDB

The NRC staff confirms that the reevaluated hazard results for LIP and storm surge are not bounded by the current design-basis flood hazard. Therefore, the NRC staff anticipates that the licensee will perform additional assessments (i.e., integrated assessment or focused evaluation) of plant response for Calvert Cliffs, Units 1 and 2, as described in NRC letter dated September 1, 2015 (NRC, 2015d). The NRC staff reviewed the following flood hazard parameters needed to perform the additional assessments or evaluations of plant response:

- Flood event duration, including warning time and intermediate water surface elevations that trigger actions by plant personnel, as defined in

Japan Lessons-Learned Directorate (JLD) Interim Staff Guidance (ISG) JLD-ISG-2012-05. Flood event durations for the flood-causing mechanisms identified in sections above are shown in Table 4.0-1.

- Flood height and associated effects. Reevaluated flood height and associated effects for the flood-causing mechanisms identified in sections above are shown in Table 4.0-2 and Table 4.0-3.

The NRC staff requested in RAI 7 (NRC, 2014a) that the licensee provide flood event duration parameters and the basis for these parameters:

- RAI 7: The March 12, 2012, 50.54(f) letter, Enclosure 2, requests the licensee to perform an integrated assessment of the plant's response to the reevaluated hazard if the reevaluated flood hazard is not bounded by the current design basis. The licensee is requested to provide the applicable flood event duration parameters (see definition and Figure 6 of the Guidance for Performing an Integrated Assessment, JLD-ISG-2012-05) associated with mechanisms that trigger an integrated assessment. This includes (as applicable) the warning time the site will have to prepare for the event, the period of time the site is inundated, and the period of time necessary for water to recede off the site for the mechanisms that are not bounded by the current design basis. Also, the licensee is requested to provide a basis for the flood event duration parameters. The basis for warning time may include information from relevant forecasting methods (e.g., products from local, regional, or national weather forecasting centers).

In a February 10, 2014, response (CENG, 2014b), the licensee summarized the flood duration parameters for LIP and probable maximum storm surge (PMSS), as shown in Table 4.0-1. The licensee provided discussions, diagrams, figures and tables for the PMP and PMSS events including flood duration, hydrodynamic loading, sediment deposition/erosion, debris, adverse weather, groundwater ingress and other pertinent factors. Based upon the preceding analysis, staff confirms that the reevaluated flood hazard information defined in the sections above is appropriate input to other assessments or evaluations associated with Near-Term Task Force Recommendations, including the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and staff).

## 5.0 CONCLUSION

The NRC staff has reviewed the information provided for the reevaluated flood-causing mechanisms of Calvert Cliffs. Based on its review, the NRC staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance used by the staff in connection with early site permit and COL reviews.

Based on the preceding analysis, the NRC staff confirmed that the licensee responded appropriately to Enclosure 2, Required Response 2, of the 50.54(f) letter, dated March 12, 2012. In reaching this determination, the NRC staff confirmed the licensee's conclusions that (a) the reevaluated flood hazard results for local intense precipitation and storm surge are not bounded

by the current design-basis flood hazard, (b) additional assessments of plant response will be performed for the local intense precipitation and the storm surge flood-causing mechanisms, and (c) the reevaluated flood-causing mechanism information is appropriate input to additional assessments or evaluations of plant response, as described in the 50.54(f) letter and COMSECY-15-0019 (NRC, 2015b), including the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and staff).

The NRC staff has no additional information needs at this time with respect to the FHRR.

## REFERENCES

### U.S. Nuclear Regulatory Commission Documents and Publications

NRC (U.S. Nuclear Regulatory Commission), 2015a, letter from Robert F. Kuntz, Senior Project Manager, Hazards Management Branch, to George H. Gellrich, Vice President, Exelon Generation Company, LLC, SUBJECT: Calvert Cliffs Nuclear Power Plant, Units 1 and 2 – Staff Assessment of Response to 10 CFR 50.54(F) Information Request- Flood-Causing Mechanism Reevaluation (TAC NOS. MF3097 AND MF3098), April 16, 2015, ADAMS Accession No. ML15077A103.

NRC (U.S. Nuclear Regulatory Commission), 2015b, SRM – COMSECY-15-0019 – Closure Plan for the Reevaluation Of Flooding Hazards for Operating Nuclear Power Plants," COMSECY-15-0019, July 28, 2015, ADAMS Accession No. ML15209A682.

NRC (U.S. Nuclear Regulatory Commission), 2015c, "Closure Plan for the Reevaluation of Flooding Hazards for Operating Nuclear Power Plants," COMSECY-15-0019, June 30, 2015, ADAMS Accession No. ML15153A104.

NRC (U.S. Nuclear Regulatory Commission), 2015d, letter from William M. Dean, Director, to Power Reactor Licensees, SUBJECT: Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond Design Basis External Events, September 1, 2015, ADAMS Accession No. ML15174A257.

### Codes and Standards

There are no additions to the references in this section.

### Other References

There are no additions to the references in this section.

**Table 3.1-2. Current Design-Basis Flood Levels**

| Flooding Mechanism | DB Stillwater Level, ft (m) NGVD29 | DB Associated Effects | Current DB Flood Level, ft (m) NGVD29 | Reference |
|---|---|---|---|---|
| Local Intense Precipitation and Associated Drainage | 44.8 (13.6) | Not Discussed in CDB | 44.8 (13.6) | SRP Section 2.1 |
| Streams and Rivers | Not Discussed in CDB | Not Discussed in CDB | Not Discussed in CDB | SRP Section 2.2 |
| Failure of Dams and Onsite Water Control/Storage Structures | Not Discussed in CDB | Not Discussed in CDB | Not Discussed in CDB | SRP Section 2.3 |
| Storm Surge | 17.6 (5.4) | 9.5 (2.9) due to wave runup at intake | 27.1 (8.3) at Intake[1] | SRP Section 2.4 |
| Seiche | Not Discussed in CDB | Not Discussed in CDB | Not Discussed in CDB | SRP Section 2.5 |
| Tsunami | Not Discussed in CDB | Not Discussed in CDB | Not Discussed in CDB | SRP Section 2.6 |
| Ice-Induced | Not Discussed in CDB | Not Discussed in CDB | Not Discussed in CDB | SRP Section 2.7 |
| Channel Migrations or Diversions | Not Discussed in CDB | Not Discussed in CDB | Not Discussed in CDB | SRP Section 2.8 |

[1]This value is based on a physical model (CEGG, 2007). In the walkdown report (CENG, 2012b), the licensee used the calculated value of 27.5 ft (8.38 m) as the design basis. See discussion in FHRR Section 3.5.1.

**Table 4.0-1. Flood Event Duration for Flood-Causing Mechanisms Not Bounded by the Current Design-Basis**

| Flood-Causing Mechanism | Site Preparation for Flood Event | Period of Site Inundation | Recession of Water from Site |
|---|---|---|---|
| Local Intense Precipitation and Associated Drainage | More than 24 h | 1.5 h | 2 to 3 h |
| Storm Surge | 48 h | No specific duration for the PMSS event was defined in the RAI 7 response (CENG, 2014a). This duration will be reviewed as part of the integrated assessment. | |

**Table 4.0-2. Reevaluated Flood Hazards for Flood-Causing Mechanisms Not Bounded by the Current Design-Basis**

| Flood-Causing Mechanism | Stillwater Elevation m (ft) NGVD29 | Associated Effects ft (m) | Reevaluated Flood Hazard ft (m) NGVD29 | FHRR Section[1] |
|---|---|---|---|---|
| Local Intense Precipitation and Associated Drainage | 45.1 to 47.0 (13.7 to 14.3) | NA | 45.1 to 47.0 (13.7 to 14.3) | 2.1 |
| Storm Surge | 17.5 (5.33) | 13.8 (4.2) due to wave runup | 31.3 (9.54) | 2.4 |

[1]Flood Hazard Reevaluation Report (CENG, 2013a)

**Table 4.0-3. Associated Effects Inputs**

| Associated Effects Factor | Local Intense Precipitation | Storm Surge |
|---|---|---|
| Hydrodynamic loading at plant grade | Determined by licensee to be minimal based on site conditions. | Determined by licensee to be minimal based on site conditions.<br><br>See Figure 4 in RAI 7 response, Attachment 1 (CENG, 2014a) and UFSAR (CENG, 2011), Section 2.8.3.6, Structural Analysis of the Intake Structure and Conclusions. |
| Debris loading at plant grade | Determined by licensee to be minimal based on site conditions. | No specific debris load identified by licensee.<br><br>Existing UFSAR states intake structure can withstand impact of baffle wall plate without damage to the intake structure (FHRR Section 3). |
| Sediment loading at plant grade | Determined by licensee to be minimal based on site conditions. | Determined by licensee to be minimal based on site conditions. |
| Sediment deposition and erosion | Sediment, erosion and scour determined by licensee to be minimal based on site conditions and impermeable surfaces. | Scour is not expected by licensee as stated in UFSAR (CENG, 2011), Section 2.8.3.6. |

| Associated Effects Factor | Local Intense Precipitation | Storm Surge |
|---|---|---|
| Concurrent conditions, including adverse weather | No specific concurrent condition evaluated by licensee. Interim actions to be performed prior to the expected PMP event. | No specific concurrent condition evaluated by licensee. Interim actions[1] to be performed prior to expected PMSS storm. |
| Groundwater ingress | Interim actions to Auxiliary Building to preclude ingress.<br>Intake Structure and 1A Diesel Generator not susceptible.<br>Turbine Building evaluated for Ingress during PMP with all ingress paths open and it was determined by licensee that no safety significant SSCs would be affected. | None determined by licensee. |
| Other pertinent factors (e.g., waterborne projectiles) | None noted by licensee. | Intake Structure roof ventilation louvers - Wind and hydrodynamic loading and wind driven missiles.<br>No specific debris loading identified by licensee. |

**Table 5.0-1: Integrated Assessment Open Item**

**Deleted**

COMSECY-15-0019 (ADAMS Accession No. ML15153A104) that described the NRC's mitigating strategies and flooding hazard reevaluation action plan.

As documented in the NRC staff assessment and the enclosed supplement, the staff has concluded that the licensee's reevaluated flood hazard information is suitable for the assessment of mitigation strategies developed in response to Order EA-12-049 (i.e., defines the mitigating strategies flood hazard information described in guidance documents currently being finalized by the industry and staff) for Calvert Cliffs. Further, the licensee's reevaluated flood hazard information is suitable for other assessments associated with Near-Term Task Force Recommendation 2.1 "Flooding".

The reevaluated flood hazard results for local intense precipitation and storm surge were not bounded by the current design-basis flood hazard. In order to complete its response to Enclosure 2 to the 50.54(f) letter, the licensee is expected to submit a revised integrated assessment or a focused evaluation, as appropriate, to address these reevaluated flood hazards, as described in the NRC's September 1, 2015, letter.

If you have any questions, please contact me at (301) 415-6197 or email at Tekia.Govan@nrc.gov.

Sincerely,

***/RA/***

Tekia Govan, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318
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Supplement to Staff Assessment of Flood Hazard Reevaluation Report
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**ADAMS Accession No.: ML15281A218** ***via email**

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