Importance measures in ranking piping components for risk informed in-service inspection

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Abstract

Risk informed in-service inspection aims at prioritising the components for inspection within the permissible risk level thereby avoiding unnecessary inspections. Various methods have been evolved for prioritisation, in which the importance measure approach has gained a wide popularity. This paper presents an importance measure that can be employed to prioritise components of any dimension, which is normally required from the point of view of carrying out a risk informed in-service inspection of nuclear power plants.

Keywords: Probabilistic safety assessment; Risk informed in-service inspection; Importance measures; Differential importance measure

1. Risk informed in-service inspection

In-service inspection (ISI) of nuclear power plants is essential for ensuring reliable performance, structural integrity and containment, i.e. leak tightness of all critical components, through non-destructive evaluation (NDE) of defects, stresses, corrosion, dimensional changes and micro-structural degradation in components during their service life, due to exposure to radiation, high temperature, pressure, loads and hostile media. Current ISI programs are based on past experience and engineering judgement through deterministic analysis. Service experience has indicated that failures are dominated by corrosion or fatigue mechanisms. The probable areas of failure are determined by deterministic analysis and are included in ISI programs. Studies are underway for development of alternate methodologies for suggesting an ISI program in compliance with plant safety levels.

Research is being conducted in order to establish the suitability in applying the risk informed technology for suggesting an ISI plan. The process of using probabilistic safety assessment (PSA) information and insights to support the ISI is termed as risk informed in-service inspection (RI-ISI). The goal of RI-ISI is to advance the development of risk technologies and implement these technologies to establish effective structural integrity management programs, reduce plant down time, industry and regulatory burdens, and continue to maintain plant safety.

In conducting ISIs it is important to have an inspection plan that is optimised to provide effective inspections at the right location with a proper inspection frequency. PSA methodology provides a technical basis for inspection plans and also to ensure that plant operates in the safe domain within the prescribed risk levels. Using this risk informed approach [1,2], it has been demonstrated that this method can identify and prioritise the most risk important systems for inspection. Various methodologies for ranking the components using risk informed approach, viz. importance measures, matrix definition, etc. have been evolved [3,4].

The various steps in carrying out RI-ISI can be summarized as below:

- Identification of systems and boundaries using information from a plant PSA.
- Ranking of components applying the risk measures to determine the categories that are then reviewed to add deterministic insights in making final selection of where to focus ISI resources.
- Determination of effective ISI programs that define when and how to appropriately inspect or test the two categories of high safety significant and low-safety significant components.
Performing the ISI to verify structural integrity of component and then updating the risk ranking based on inspection and test results.

Even though this methodology can be extended to any components subjected to ISI, for the purpose of studies piping has been considered as the component of interest.

2. Importance measures

There are two principal factors that determine the importance of the component in a system: (i) the function of the system, i.e. frequency of the challenge and availability of the backup trains and (ii) the reliability or unreliability of the components. Because nuclear power plants are designed according to the defence-in-depth principle, one single failure of a component or other basic event will probably not result in a large accident. More likely, a large accident will be the result of failure of multiple basic events. The PSA methodology determines important combinations or in other words, cut sets that could result in a large accident.

A risk importance measure gives an indication of the contribution of a certain component to the total risk. Various methods are available for measuring the importance of components. The most commonly available measures are:

Risk achievement worth (RAW) of a system is defined as the increase in risk (in terms of CDF), when the system is failed or removed from service.

\[
\text{RAW} = \frac{\text{CDF}(x_i = 1)}{\text{CDF}(\text{base})}
\]

Risk reduction worth (RRW) of a system is defined as the reduction in risk (in terms of CDF), when the system is fully reliable.

\[
\text{RRW} = \frac{\text{CDF}(\text{base})}{\text{CDF}(x_i = 0)}
\]

where CDF(x_i = 1) is the risk level, when the particular system is unavailable; CDF(x_i = 0), the risk level, when particular system unavailability is zero; CDF(base) is the time averaged CDF.

Birnbaum importance (I^b) of a component is defined as the ratio of the component unreliability or unavailability to system unreliability or unavailability. This measure is simple and influenced by the logic structure of the system

\[
I^b_{xi} = \text{CDF}_{x_i=1} - \text{CDF}_{x_i=0}
\]

Birnbaum importance of the system is the sum of the Birnbaum importances of the components in the system.

\[
I^b_{\text{sys}} = \sum_{x_i} I^b_{xi}
\]

x_i is the i\text{th} component in system.

Another importance measure that has been widely used is the Fussell–Vesely (FV) importance. FV importance is a normalised RR importance and is comparable to RRW. FV is usually termed as an indicator for risk significance.

Fussell–Vesely importance (FV) for a single basic event basically represents the fraction of the risk measure to which the basic event contributes, i.e. it is the sum of the cut sets involving the basic event divided by the sum of all cut sets.

\[
\text{FV} = \frac{(\text{CDF}(\text{base}) - \text{CDF}(x_i = 0))}{\text{CDF}(\text{base})}
\]

The RAW signifies the importance of the system in achieving the present level of safety. The RRW represents the maximum decrease in risk for an improvement to the element associated with the basic event. The RRW suggests the system or components that can reduce the risk effectively, if modified suitably. The importance measures like RAW, RRW, etc. have found many applications in various risk informed decision making issues such as optimisation of allowed outage time, surveillance test interval, etc. Birnbaum and FV have been suggested by ASME[3,4] for RI-ISI. In most of the applications, the exact ranking is not important. If determination of component importance is required for more than ranking, uncertainty analysis is suggested. In general, importance measures have been employed widely in various decision making issues [3,4].

In the case of ISI, it will be carried out for piping segments from process systems as well as safety systems. When we apply RAW, we have to assume the piping segment totally unavailable. In case of a safety system, the piping segment unavailabilities can be assumed to be 1 or 0 and conventional importance measures can be computed. In the case of a process system, the piping segment failure is expressed in terms of initiating event frequencies. Since the initiating event frequency cannot be defined as ‘totally unavailable’, difficulties will arise in applying conventional importance measures. Hence, these importance measures do not provide us the facility to compare the ranking of process system piping segments as well as safety system piping segments. This paper discusses an importance measure approach for ranking different piping segments for ISI. Our approach uses a recently developed importance measure, the differential importance measure (DIM) [5].

3. Differential importance measure

3.1. Definition of DIM

Differential importance measure (DIM) can be defined as the fraction of total change in R that is due to a change in parameter x_i.

\[
\text{DIM}_{x_i} = \frac{\delta R_{x_i}}{\delta R} = R(x_i + \delta x_i) - R_0
\]

\[
\delta R = \sum_i \delta R_i
\]
where CDF is the core damage frequency from the PSA model and \( x_i \) are the components appearing in the PSA model.

Borgonovo and Apostolakis [5] suggested two schemes for evaluating the change in risk caused by changes in \( x_i \) either by changing each parameter by a small amount or by changing by the same percentage. These schemes can be represented as two hypotheses H1 and H2.

H1 can be defined as:
\[
\delta x_i = \delta x_j \quad \forall i, j
\]

H2 can be defined as:
\[
\frac{\delta x_i}{x_i} = \frac{\delta x_j}{x_j} = \omega \quad \forall i, j
\]

When analysing the basic events of PSA models, since these basic event probabilities have the same dimension, both H1 and H2 are applicable. When analysing the PSA model at the parameter level, H1 is not applicable since the parameters have different dimensions. For RI-ISI, the piping segment is represented in terms of failure frequency whereas for safety systems, the piping segment is represented in terms of failure probability. In this case, only H2 can be used for DIM evaluation so that all piping segments can be ranked in the same basis.

### 3.2. Steps for computing DIM

The operational definition of DIM in Eq. (5) can be defined as follows [5]:
\[
r_j(\delta x) = \frac{\delta R_{x_j}}{\delta R} = \frac{R(x_i + \delta x_i) - R_0}{\sum_j R(x_j + \delta x_j) - R_0}
\]

where \( \delta x \) is the vector of all parameter changes. The quantity \( r_j(\delta x) \) converges to a finite limit \( \operatorname{Dim}(x_i) \), as \( \delta x_i \) tends to zero. Then Zermelo’s theorem guarantees that, since \( r_j(\delta x) \) converges to \( \operatorname{Dim}(x_i) \) on a continuous set, it will converge to the same limit for every sequence of \( \delta x_i^j \) (where \( j \) denotes the \( j \)th element of the sequence of elements of the set such that \( \lim_{j \to \infty} \delta x_j = 0 \)). Thus, we can focus our attention on the sequence of the quantities \( r_j^i \)
\[
r_j = r_j(\delta x) = \left( \frac{\delta R_{x_j}}{\delta R} \right)^i
\]

This sequence tends to \( \operatorname{Dim}(x_i) \) as the sequence of \( \delta x_i^j \) progresses. Cauchy’s convergence criterion holds true here also. For every small number \( \varepsilon \) there exists an index \( N \), such that for all \( m \) and \( n \) greater than \( N \)
\[
|r(\omega^m) - r(\omega^n)| < \varepsilon
\]

The above steps can be summarized as follows:

1. Define a sequence \( \delta x_j \).
2. For each sequence, perform the computational steps.
3. Set a discrepancy level \( \varepsilon \).
4. Use Cauchy’s convergence criterion to test the convergence.

A detailed discussion of this importance measure with examples is presented by Borgonovo and Apostolakis in Ref. [5].

### 3.3. Analysis of delta increase in DIM

Borgonovo and Apostolakis [5] suggested various approaches for evaluation of \( \delta x_i \), viz. Cauchy’s sequence convergence, FORM’s approach, Greens function. Cauchy’s approach does not require evaluation of partial derivatives, whereas other approaches require the evaluation of partial derivatives. A simple algorithm is proposed to evaluate DIM using Cauchy’s sequence convergence approach.

A sequence of increasing integers \( \omega_i \), with \( \omega_i \) tending to infinity, where
\[
\omega_i^0 = \epsilon_0
\]
\[
\omega_i^{-1} = m \omega_i^q
\]

with \( \epsilon_0 \) and \( m \) are arbitrary. Then,
\[
\delta x_i^j = \frac{X_i}{\omega^q}
\]

Then \( \delta x_i^j \) will tend to zero as \( \omega^q \) increases. After the sequence has been defined, Cauchy’s sequence convergence criterion is applied. For every predetermined and small discrepancy \( \varepsilon \), there will be an index \( j \) such that
\[
\left| r(\omega^q) - r(\omega^j) \right| < \varepsilon
\]

where the index \( q \) varies from 1 to infinity. For the reference example below, \( \epsilon_0 = 1 \), \( m = 2 \), \( \varepsilon = 0.01 \) and \( q = 1 \). The example below converged in four iterations.

### 4. Numerical example

To discuss the importance of ranking of piping segments from process and safety systems, we consider the simple case of an initiating event and a safety system. The initiating event is assumed to be a medium loss of cooling accident (MLOCA). This initiating event can occur when there is a failure in the piping resulting in loss of inventory. The piping failure frequency includes the failure frequency from the main primary heat transport (PHT) line and feeders. When this initiating event occurs, the safety system, the emergency core cooling system (ECCS), will act as the mitigating system. Risk from this event can be defined as the frequency of occurrence of this initiating event coupled with the unavailability of the ECCS.


The risk metric \( R \) is computed as the core damage frequency resulting from a MLOCA incident coupled with loss of availability of ECCS. Accident sequences from other initiating events are not considered in this case study. Thus

\[
\text{CDF}_{\text{MLOCA}} = f_{\text{MLOCA}} q_{\text{ECCS}}
\]

where \( f_{\text{MLOCA}} \) is the MLOCA frequency and \( q_{\text{ECCS}} \) is the ECCS unavailability.

4.1. Frequency of MLOCA

The PHT system consists of two inlet headers and two outlet headers. The outlet header is connected to steam generator, which in turn to primary coolant pump. The primary coolant pump is connected to inlet header. Table 1 presents the various piping segments considered for process system PHT system.

**Assumptions**

(i) System boundary is considered at feeders and channels are not included for ranking.

(ii) MLOCA can occur if there is pipe failure in any of these components.

(iii) The failure frequency of basic event includes failure frequencies of welds, elbows, joints, etc. From the point of view of ISI, basic events should be analysed at the weld level. Since this paper aims at highlighting the application of importance measures, basic events are considered in a broad sense.

(iv) When the leak rate of coolant from the system is higher than 50 gpm, the piping is considered failed.

(v) Failure frequencies are representative figures to emphasis the suitability of importance measure and do not represent the actual figures.

Since all the piping components are assumed to be in series, the MLOCA frequency is found to be \( 1.14 \times 10^{-3} \text{yr} \). Even though individually all component failures are MLOCA, their combined effect is considered in this case study.

4.2. Reliability analysis of ECCS

The ECCS consists of four accumulators, where each accumulator holds 60 m\(^3\) of cold water and 10 m\(^3\) of nitrogen at 5 MPa (50 kg/cm\(^2\)) pressure. The accumulators are connected through check valve and rupture disc to main header from each line. Main header is connected to the channels through feeders. Each channel consists of eight perforated water tubes, through which cold water ejects directly on the fuel pins. These water tubes are arranged in a manner to ensure adequate cooling of pins during LOCA.

For the estimation of ECCS unavailability, the contribution comes from actuation logic, accumulator system, piping, etc. For the purpose of our studies, we have broadly classified unavailability contribution as from piping and non-piping components. In order to analyse the aspect of ISI, emphasis has been given on piping failure contribution from ECCS lines and header.

**Assumptions**

(i) System boundary is considered at accumulator and individual header. Other components such as inlet valves, nitrogen supply, etc. are not considered for ranking.

(ii) System success criterion is ‘water from any three out of four lines reaching the common header’.

(iii) Failure probability of basic event ‘piping’ includes failure probabilities of welds, elbows, joints, etc.

### Table 1

List of piping segments to be ranked and their data

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Description</th>
<th>Frequency (/yr)</th>
<th>Sl. no.</th>
<th>Description</th>
<th>Unavailability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feeder–header 1</td>
<td>9.2 \times 10^{-5}</td>
<td>1</td>
<td>EICOREPIP</td>
<td>2.43 \times 10^{-3}</td>
</tr>
<tr>
<td>2</td>
<td>Feeder–header 2</td>
<td>8.9 \times 10^{-5}</td>
<td>2</td>
<td>EICHV1</td>
<td>1.0 \times 10^{-4}</td>
</tr>
<tr>
<td>3</td>
<td>Feeder–header 3</td>
<td>6.5 \times 10^{-5}</td>
<td>3</td>
<td>EIPIP1</td>
<td>8.85 \times 10^{-4}</td>
</tr>
<tr>
<td>4</td>
<td>Feeder–header 4</td>
<td>9.8 \times 10^{-5}</td>
<td>4</td>
<td>EIRD1</td>
<td>2.21 \times 10^{-3}</td>
</tr>
<tr>
<td>5</td>
<td>Header–steam generator</td>
<td>1 \times 10^{-6}</td>
<td>5</td>
<td>EICHV2</td>
<td>1.0 \times 10^{-3}</td>
</tr>
<tr>
<td>6</td>
<td>Steam generator–pump</td>
<td>4 \times 10^{-6}</td>
<td>6</td>
<td>EIPIP2</td>
<td>1.11 \times 10^{-3}</td>
</tr>
<tr>
<td>7</td>
<td>Pump–header</td>
<td>6 \times 10^{-6}</td>
<td>7</td>
<td>EIRD2</td>
<td>2.21 \times 10^{-3}</td>
</tr>
<tr>
<td>8</td>
<td>Coolant channel</td>
<td>1.77 \times 10^{-5}</td>
<td>8</td>
<td>EICHV3</td>
<td>1.0 \times 10^{-4}</td>
</tr>
<tr>
<td>9</td>
<td>Header 1</td>
<td>1.91 \times 10^{-4}</td>
<td>9</td>
<td>EIPIP3</td>
<td>1.6 \times 10^{-3}</td>
</tr>
<tr>
<td>10</td>
<td>Header 2</td>
<td>1.91 \times 10^{-4}</td>
<td>10</td>
<td>EIRD3</td>
<td>2.21 \times 10^{-3}</td>
</tr>
<tr>
<td>11</td>
<td>Header 3</td>
<td>1.91 \times 10^{-4}</td>
<td>11</td>
<td>EICHV4</td>
<td>1.0 \times 10^{-4}</td>
</tr>
<tr>
<td>12</td>
<td>Header 4</td>
<td>1.91 \times 10^{-4}</td>
<td>12</td>
<td>EIPIP4</td>
<td>1.14 \times 10^{-3}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td>EIRD4</td>
<td>2.21 \times 10^{-3}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>EICCF1</td>
<td>1.0 \times 10^{-4}</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td>EIMHDR</td>
<td>3.0 \times 10^{-3}</td>
</tr>
</tbody>
</table>
(iv) Basic event probabilities are representative figures to emphasize the suitability of importance measure and do not represent the actual figures.

(v) EICCF1, the common cause component, represents the failure of ECCS resulting from failure in common actuation signal.

The fault tree for ECCS failure is shown in Fig. 1. The basic event failure probabilities are given in Table 1. The fault tree has been analysed using PSAPACK 4.2 and minimal cut sets are obtained. Since the cut set truncation probability was taken as $10^{-10}$, 79 cut sets were obtained for system unavailability calculation. The system unavailability was found to be $5.5 \times 10^{-3}$.

4.3. Issues in risk ranking

Piping segments from two systems are involved in the above risk calculations (given in Eq. (8)), viz. the PHT system and the ECCS. The failure parameters of interest for the PHT system and the ECCS are failure frequency and unavailability, respectively. For ranking the piping segment in ECCS using RAW, FV or Birnbaum, the unavailability can be made one and all piping segments can be ranked. However, for piping segments in the PHT, the frequency cannot be made 1 or 0 for risk ranking. Hence, these importance measures are not suitable for ranking components of process systems, where frequency is the failure parameter of interest.

However, since all components in ECCS can be ranked, Table 2 provides a comparative evaluation of ranking the components using Birnbaum, FV and the DIM. It can be found that if more than one component falls under single failure criteria, Birnbaum gives the same ranking. Since FV multiplies this measure by the corresponding failure probability, some ranking can be established. DIM also gives a ranking that is the same as that from FV. Ref. [5] discusses the conditions under which the DIM and FV rankings are the same.

When planning the ISI programme, all piping segments should be ranked in the same table irrespective of system, type of the system, and their function. Under such circumstances, ranking the piping segments from process as well as safety systems requires various approximations when using conventional importance measures. The new measure, DIM, facilitates the ranking of piping segments.
from process systems and safety systems. In other words, whatever the failure parameter of interest may be, the elements can be ranked with respect to their effect on risk.

### 4.4. Estimation of failure parameters for piping

Estimation of piping failure parameter is a crucial task since this form the basis for further analyses. Three methods have been suggested for piping failure probability estimation:

(i) **Structural reliability analysis.** SRA employs the use of probabilistic fracture mechanics techniques to calculate the failure probability as a function of time, including the effects of inspection frequency, probability of detection (POD) and degradation mechanism. Through Monte Carlo sampling, the results of tracking a very large number of crack simulations can be used to determine what fraction of cracks will not be detected and repaired before failure results. This methodology provides models for determining the crack growth for different degradation mechanisms also. Computer codes like PC-PRAISE, etc. are available for carrying out such analysis. These models are computationally intensive. The results of these analyses are often driven by uncertainties in defining crack size distribution, stress history, detection probability, and reference flaw size. Moreover, these estimates are too small and yet to be reconciled against service experience.

(ii) **Service data analysis.** Databases are an important source of information that can support the estimation. Various studies have been conducted by WASH 1400 and IAEA, through which they are able to bring out some estimates. Statistical estimates of pipe failure frequencies are derived as key factors associated with pipe failure mechanisms (degradation mechanisms and loading conditions).

(iii) **Expert opinion.** The degree to which one relies on one method or another is predicted on the availability of data from service experience, experts, or structural reliability models. In the present case study, some representative values from service data analysis.

### 5. Results and discussion

For the above numerical example, the DIM was applied and all piping segments listed in Table 1 are ranked. The results of the analysis are shown in Table 3. Considering the above accident sequence, all the piping components from PHT as well as ECCS are ranked for inspection based on DIM.

From Table 3, it can be seen that the piping segment from the ECCS header to core is the high safety significant component. Similarly, other PHT piping segments are ranked below. It can be seen that EICOREPIP is in terms of unavailability whereas header 1, feeder–header 1, etc. are in terms of failure frequency. Uncertainty analysis was conducted on DIM using Monte Carlo methods. Lognormal distribution is assumed for all components, with an error factor of 10. Even though the mean DIM is different slightly from the point value DIM, the ranking remained the same. While planning ISI according to the ranking, more attention can be paid to high safety significant component, thereby ensuring the plant safety. Moreover, allocation of ISI resource will be tuned such that unnecessary ISI to low safety significant component can be reduced. This not only optimises the ISI but also prevents unnecessary worker radiation exposure.

DIM is well suited for the applications such as RI-ISI where components with different dimension is to be ranked. Even though ASME has suggested an importance measure
similar to FV, because of the above limitation, they used it for ranking only safety systems. But DIM overcomes the above limitation. This is very important since an overall piping segment ranking should be done for preparing an ISI programme.

6. Conclusions

An ISI programme includes various components from process as well as safety systems. In order to increase the availability of plants, the ISI programme will be scheduled during plant shutdowns during which critical components are inspected. Mostly components are scheduled based on some deterministic ranking procedures. RI-ISI provides a consequence-based criterion for ranking components. Using the DIM, components can be ranked regardless of whether the parameter of interest is a probability or frequency. This has been demonstrated in this paper by successfully ranking the piping segments from process and safety systems, which are expressed in frequency and unavailability, respectively. Thus, a suitable ISI programme can be established based on its contribution towards risk to a plant.

References


Table 3

<table>
<thead>
<tr>
<th>Piping segment</th>
<th>DIM value</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Point</td>
<td>Mean</td>
</tr>
<tr>
<td>EIMHDR</td>
<td>0.481179</td>
<td>0.304487</td>
</tr>
<tr>
<td>EICOREPIP</td>
<td>0.389755</td>
<td>0.276202</td>
</tr>
<tr>
<td>Header 1</td>
<td>0.0188119</td>
<td>0.0781862</td>
</tr>
<tr>
<td>Header 2</td>
<td>0.0188119</td>
<td>0.0686091</td>
</tr>
<tr>
<td>Header 3</td>
<td>0.0188119</td>
<td>0.0602457</td>
</tr>
<tr>
<td>Header 4</td>
<td>0.0188119</td>
<td>0.0512074</td>
</tr>
<tr>
<td>Feeders−header 4</td>
<td>0.00965216</td>
<td>0.0322375</td>
</tr>
<tr>
<td>Feeders−header 2</td>
<td>0.00906121</td>
<td>0.0309177</td>
</tr>
<tr>
<td>Feeders−header 3</td>
<td>0.00876573</td>
<td>0.029908</td>
</tr>
<tr>
<td>EICCF1</td>
<td>0.00738685</td>
<td>0.0110256</td>
</tr>
<tr>
<td>Channel</td>
<td>0.00174803</td>
<td>0.0101178</td>
</tr>
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<td>Pump−header</td>
<td>0.000590948</td>
<td>0.00336074</td>
</tr>
<tr>
<td>Steam generator−pump</td>
<td>0.000393966</td>
<td>0.00267627</td>
</tr>
<tr>
<td>EIRD1</td>
<td>0.154086 × 10−5</td>
<td>0.000255</td>
</tr>
<tr>
<td>EIRD2</td>
<td>0.10238 × 10−5</td>
<td>2.0615 × 10−5</td>
</tr>
<tr>
<td>EIRD3</td>
<td>0.19442 × 10−5</td>
<td>1.85165 × 10−5</td>
</tr>
<tr>
<td>EIRD4</td>
<td>0.13751 × 10−5</td>
<td>1.75973 × 10−5</td>
</tr>
<tr>
<td>EIPIP3</td>
<td>8.60781 × 10−6</td>
<td>1.31603 × 10−5</td>
</tr>
<tr>
<td>EIPIP4</td>
<td>6.72179 × 10−6</td>
<td>9.81499 × 10−6</td>
</tr>
<tr>
<td>EIPIP5</td>
<td>6.93986 × 10−6</td>
<td>9.63301 × 10−6</td>
</tr>
<tr>
<td>EIPIP6</td>
<td>5.35223 × 10−6</td>
<td>6.1479 × 10−6</td>
</tr>
<tr>
<td>EICCHV1</td>
<td>5.78052 × 10−7</td>
<td>8.91202 × 10−7</td>
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<td>5.37482 × 10−7</td>
<td>8.54941 × 10−7</td>
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<td>7.96951 × 10−7</td>
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<td>EICCHV4</td>
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<td>6.53818 × 10−7</td>
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