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| **BREVET DE TECHNICIEN SUPÉRIEUR****ENVIRONNEMENT NUCLÉAIRE** |

SESSION 2018

**\_\_\_\_\_\_**

###### Durée : 4 heures

Coefficient : 3

**\_\_\_\_\_\_**

ÉPREUVE E4 :
Modélisation et choix techniques
en environnement nucléaire

SOUS-ÉPREUVE U4.1 :
Pré-étude et modélisation

CORRIGÉ

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **60,0** | **analyse du barème sur feuille "statistiques"** |  |  |  |
|  | **1/** | **Traitement du point chaud 10,5 pts** |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| 1 |  | **1-1/** |  |  | 5826Fe + 10n |  | 5926Fe |  |  |
|  |  |  |  |  |  |  |  |  |  |
| 1 |  |  |  |  | 5927Co + 10n |  | 5926Fe + 11p |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **1-2/** |  |  | 5926Fe est émetteur - |  |  |  |
| 1 |  |  |  |  | S'il était émetteur +, une raie  à 511 keV serait citée |  |
| 1 |  |  |  |  | 5926Fe |  | 5927Co + 0-1e +  | 00 |  |
|  |  |  |  |  | (5927Co est stable) |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **1-3/** |  |  | A0 = |  180 | MBq |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | 1 | 2 | 3 |
|  |  |  |  |  | E en keV | 192 | 1 099 | 1 292 |
|  |  |  |  |  | I en % | 3% | 56% | 44% |
|  |  |  |  |  | D° en µGy/h | 0,1 | 14,4 | 13,3 |
|  |  |  |  |  | à 1 m | 27,8 |
|  |  |  |  |  | H°1 en µSv/h | 27,8 |
| 2 |  |  |  |  | à 1 m |
|  |  |  |  |  |  |  |  |  |  |
| 1 |  |  |  |  | H°1 = D°.WR | avec | WR = 1 | car  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **1-4/** |  |  | H°1 = | 27,8 | µSv/h à 1 m |  |  |
|  |  |  |  |  | x = | 13 | mm |  |  |
|  |  |  |  |  | Emax = | 1 292 | keV |  |  |
|  |  |  |  |  |  = | 11,3 | g/cm3 |  |  |
|  |  |  |  |  | µ/ = | 0,041 | cm2/g |  |  |
|  |  |  |  |  | µ = | 0,46 | cm-1 |  |  |
| 1,5 |  |  |  |  | eµx = | 1,8 |  = atténuation |  |  |
| 0,5 |  |  |  |  | H°2 = | 15,2 | µSv/h à 1 m |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | **1-5/** |  |  | d = | 1,5 | m |  |  |
| 1 |  |  |  |  | H°3 = | 6,8 | µSv/h à 1,5 m |  |  |
| 0,5 |  |  |  |  | zonage = | ZCV |  |  |  |

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|  |  |  |  |  |  |  |  |  |
|  | **2/** | **Amélioration de l’éclairage au poste de travail** | 6 pts |  |
|  |  |  |  |  |  |  |  |  |
|  |  | **2-1/** | **Eclairage existant au poste de travail** |  |  |
|  |  |  |  |  | nb tubes = | 3 |  |  |
|  |  |  |  |  | P = | 34 | W |  |
|  |  |  |  |  | d = | 2 | m |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  | **2-1-1/** |  | Eff = | 50 | lm/W |  |
| 1 |  |  |  |  |  = | 5 100 | lm |  |
|  |  |  |  |  |  |  |  |  |
| 0,5 |  |  | **2-1-2/** |  | I = | 406 | cd |  |
| 0,5 |  |  |  |  | E = | 101 | lx |  |
|  |  |  |  |  |  |  |  |  |
| 0,5 |  |  | **2-1-3/** |  | éclairage insuffisant |  |  |
|  |  |  |  |  | il faut 200 lx à minima |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  | **2-2/** | **Choix d’un nouvel éclairage** |  |  |
|  |  |  | **2-2-1/** |  | on veut |  |  |  |
| 0,5 |  |  |  |  | E > | 200 | lx |  |
|  |  |  |  |  |  |  |  |  |
| 1 |  |  | **2-2-2/** |  | I > | 800 | cd |  |
| 1 |  |  |  |  |  > | 10 053 | lm |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  | **2-2-3/** |  | proposition |  |  |  |
|  |  |  |  |  | P = | 32 | W |  |
|  |  |  |  |  | Eff = | 114 | lm/W |  |
| 1 |  |  |  |  |  = | 10 944 | lm |  |
|  |  |  |  |  |  | OK |  |  |
|  |  |  |  |  |  |  |  |  |
|  | **3/** | **Moyen de levage** | **6,5 pts** |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  | **3-1/** |  |  | PU moteur palan = | 1,0 | kW |  |
|  |  |  |  |  | réducteur = | 72% |  |  |
| 1 |  |  |  |  | PU palan = | 720 | W |  |
|  |  |  |  |  |  |  |  |  |
|  |  | **3-2/** |  |  | nmoteur palan = | 1 440 | tr/min |  |
|  |  |  |  |  | réduction = | 2 000 |  |  |
| 1 |  |  |  |  | n = | 0,72 | tr/min |  |
|  |  |  |  |  |  |  |  |  |
|  |  | **3-3/** |  |  |  = | 0,075 | rad/s |  |
|  |  |  |  |  | d = | 10 | cm |  |
|  |  |  |  |  | R = | 5,0 | cm |  |
| 1 |  |  |  |  | v = | 0,0038 | m/s |  |
| 0,5 |  |  |  |  | = | 226 | mm/min |  |
|  |  |  |  |  |  |  |  |  |
|  |  | **3-4/** |  |  | CS = | 7 |  |  |
|  |  |  |  |  | g = | 9,81 | N/kg |  |
|  |  |  |  |  | F = | 190 986 | N | sans CS |
|  |  |  |  |  | M = | 19 468 | kg |
|  |  |  |  |  | F = | 27 284 | N | avec CS = 7 |
| 2 |  |  |  |  | M = | 2 781 | kg |
|  |  |  |  |  | (le constructeur avait travaillé avec un coeff de sécu de 5) |
|  |  |  |  |  |  |  |  |  |
|  |  | **3-5/** |  |  | vitesse conforme |  |  |
|  |  |  |  |  | CS insuffisant |  |  |
| 1 |  |  |  |  | processus invalidé |  |  |
|  |  |  |  |  |  |  |  |  |
|  | **4/** | **Etude dosimétrique prévisionnelle au poste n°1** | **5,5 pts** |  |
|  |  |  |  |  |  |  |  |  |
|  |  | **4-1/** |  |  | H°3 = | 6,8 | µSv/h à 1,5 m |  |
|  |  |  |  |  | T = | 44,5 | jours |  |
|  |  |  |  |  | t = | 10 | jours |  |
|  |  |  |  |  | t/T = | 0,22 | période |  |
|  |  |  |  |  | 2Δt/T = | 1,17 |  = atténuation |  |
|  |  |  |  |  | (A = | 154 | MBq) |  |
| 1,5 |  |  |  |  |  H°4 = | 5,8 µSv/h |  à 1,5 m |  |

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|  | **4-2/** | EDP |   |   |   |   |   |   |   |   |
|  |  | Service |   |   | Nb. Inter | Durée en h | Cexpo | H°4 µSv/h | Eindiv µSv | S en H.µSv |
|  |  | ELEC | Ctrl AMSR | Hors ZC | 2 | 1 | - | 0,0 | 0,0 | 0,0 |
|  |  |   | Débrochage moteur |   | 2 | 2 | 0,8 | 5,8 | 9,3 | 18,5 |
|  |  | AUTO | Démontage capteurs |   | 2 | 1,5 | 0,9 | 5,8 | 7,8 | 15,6 |
|  |  | MECA | Maintenance pompe |   | 3 | 8 | 0,6 | 5,8 | 27,8 | 83,3 |
|  |  | AUTO | Remontage capteurs |   | 2 | 1,5 | 0,9 | 5,8 | 7,8 | 15,6 |
|  |  | ELEC | Ctrl AMSR | Hors ZC | 2 | 1 | - | 0,0 | 0,0 | 0,0 |
|  |  |   | Rebrochage moteur |   | 2 | 2 | 0,8 | 5,8 | 9,3 | 18,5 |
|  |  |  |  |  |  | 17 |  |  | 61,9 | 152 |
|  |  | 2 pts | H = | H°.t.Cexpo |  |  |  |  |  |  |
|  |  | 1pt |  | E = H.WT  | avec | WT = 1 | car corps entier |  |  |
|  |  | 1 pt |  | S = | individuelle |  |  |  |  |  |
|  |  | **5/** | **Situation dégradée lors de la maintenance de la pompe** | **11,5 pts** |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | t = | 30 | min |  |  |
|  |  |  |  |  |  | = | 0,5 | h |  |  |
|  |  |  |  |  |  | AV0 = | 11,5 | kBq/m3 |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **5-1/** |  **Evaluation de la dose engagée** |  |  |  |
|  |  |  |  |  |  | Q = | 1,2 | m3/h |  |  |
|  |  |  |  |  |  | h(g) = | 1,1.10-08 | Sv/Bq |  |  |
|  | 1 |  |  |  |  | Ainh = | 6,9 | kBq |  |  |
|  | 1 |  |  |  |  | Einh = | 76 | µSv |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **5-2/** | **Incidence sur le zonage du local** |  |  |  |
|  | 1 |  |  |  |  | 1.RCA = | 1,9 | kBq/m3 |  |  |
|  | 1 |  |  |  |  | n.RCA = | 6,1 | RCA |  |  |
|  | 0,5 |  |  |  |  | zonage = | ZCJ |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **5-3/** | **Assainissement du local** |  |  |  |  |
|  |  |  |  |  |  | QV = | 85 | m3/h |  |  |
|  |  |  |  |  |  | Vlocal = | 120 | m3 |  |  |
|  |  |  |  |  |  | R = | 0,71 | h-1 |  |  |
|  |  |  |  |  |  | H°4 = | 5,8 | µSv/h  | à 1,5 m |  |
|  |  |  |  |  |  | classement en ZCV dès que : |  |  |
|  |  |  |  |  |  | Einh + ext < | 25 | µSv en 1 h |  |  |
|  |  |  |  |  |  | càd, dès que : |  |  |  |
|  |  |  |  |  |  | Einh < | 19,2 | µSv en 1 h |  |  |
|  |  |  |  |  |  | soit : |  |  |  |  |
|  |  |  |  |  |  | AV < | 0,77 | RCA |  |  |
|  |  |  |  |  |  | donc : |  |  |  |  |
|  | 3 |  |  |  |  | tventil = | 2,9 | h = | 2 h 55 min |  |
|  |  |  |  |  |  |  |  |   |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **5-4/** | **Analyse des causes pour alimenter le REx** |  |  |  |
|  |  |  |  | **5-4-1/** |  | H°gaz = | 6,5 | µSv/h à 10 cm |  |
|  | 1 |  |  |  |  | x = | 50 | mm |  |  |
|  |  |  |  |  |  | µ = | 0,86 | cm-1 |  |  |
|  |  |  |  |  |  | eµx = | 73,7 |  = atténuation |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | 0,5 |  |  | **5-4-2/** |  | H°gaz-écran = | 0,1 | µSv/h | à 10 cm |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | **5-4-3/** |  | H° = | 7,60. 10-07 | µSv/h par Bq/m3 |  |
|  | 1 |  |  |  |  | H° = | 8,7 | nSv/h |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | 0,5 |  |  | **5-4-4/** |  | Gaz non détectable (ne constitue pas un point chaud) |  |
|  | 0,5 |  |  |  |  | Evolution du DED ambiant non détectable |  |
|  | 0,5 |  |  |  |  | Parade : prévoir une balise aérosols ou à iode |  |
|  |  |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **6/** | **Avis médical** |  |  | **2,5 pts** |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | 0,5 |  | **6-1/** |  |  | anthropogammamétrie | ou | anthroporadiamétrie |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **6-2/** |  |  | Aint = | 6,5 | kBq |  |  |
|  |  |  |  |  |  | T = | 8,0 | jours |  |  |
|  |  |  |  |  |  | Tb = | 140 | jours |  |  |
|  |  |  |  |  |  | Te = | 7,6 | jours |  |  |
|  |  |  |  |  |  | t = | 60 | jours |  |  |
|  |  |  |  |  |  | t/T = | 7,9 | périodes |  |  |
|  |  |  |  |  |  | 2Δt/T = | 244 |  = atténuation |  |
|  | 2 |  |  |  |  | Aint = | 26,7 | Bq | négligeable |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | **7/** | **Requalification fonctionnelle** | **17,5 pts** |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **7-1/** | **Contrôle du débit** |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | τ = | 266,63 | µs |  |  |
|  |  |  |  |  |  | d = | 20,00 | cm |  |  |
|  |  |  |  |  |  |  = | 30 | ° |  |  |
|  | 1 |  |  |  |  |  | 0,524 | rad |  |  |
|  |  |  |  |  |  | c = | 1 500 | m/s |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | **7-1-1** |  | L = | 40,00 | cm |  |  |
|  | 1,5 |  |  |  |  | v = | 0,2382 | m/s |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  | 1 |  |  | **7-1-2/** |  | S = | 0,03142 | m2 |  |  |
|  | 1 |  |  |  |  | QVD = | 26,94 | m3/h |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | **7-1-3/** |  | U = | 6,6 | kV |  |  |
|  |  |  |  |  |  | IN = | 74 | A |  |  |
|  |  |  |  |  |  | cos  = | 0,91 |  |  |  |
|  | 1 |  |  |  |  | PAN = | 770 | kW |  |  |
|  |  |  |  |  |  | PUN = | 710 | kW |  |  |
|  | 1 |  |  |  |  |  = | 92,2% |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | **7-1-4/** |  | I = | 70 | A |  |  |
|  | 1 |  |  |  |  | PA = | 728 | kW |  |  |
|  | 1 |  |  |  |  | PU = | 672 | kW |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | **7-1-5/** |  | QV = | 1,16E-05 | PU |  |  |
|  | 1 |  |  |  |  | QV = | 0,00779 | m3/s |  |  |
|  |  |  |  |  |  |  | 28,0 | m3/h |  |  |
|  |  |  |  |  |  | QVD = | 26,9 | m3/h |  |  |
|  | 1 |  |  |  |  | QV/QV  |  =4,3% | < 5% |  |  |
|  |  |  |  |  |  | étalonnage validé |  |  |  |
|  |  |  | **7-2/** | **Contrôle de la pression** |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | 1 |  |  | **7-2-1/** |  | I = | U0/R |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | 1 |  |  | **7-2-2/** |  | U = | x.R.I |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | 1 |  |  | **7-2-3/** |  | U = | x.U0 |  |  |
|  |  |  |  |  |  |  |  |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **7-2-4/** |  | U0 = | 24,0 | V |  |
|  |  |  |  |  |  | p en bar | 100 | 200 |  |
|  |  |  |  |  |  | x | 1 | 0 |  |
|  | 1 |  |  |  |  | U en V | 24,0 | 0 |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |

|  |
| --- |
| U en V |

 |  |  |  |  |
|  |  |  |  |  | 24 |  |  |  |  |
|  |  |  |  |  |   |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | 1 |  |  |  | 0 |  |  |  |  |
|  |  |  |  |  |  | 100 |  | 200 | p en bar |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | **7-2-5/** |  |  |  |  |  |
|  |  |  |  |  |  | p = | 177 | bar |  |
|  |  |  |  |  |  | pMax - p = | 23 | bar | ou détermination graphique |
|  |  |  |  |  |  | pMax - pmin = | 100 | bar |  |
|  | 1,5 |  |  |  |  | U = | 5,52 | V |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  | **7-2-6/** |  | Umesurée = | 5,50 | V |  |
|  |  |  |  |  |  | p = | 177,1 | bar |  |
|  | 0,5 |  |  |  |  | étalonnage validé |  |  |