**Nuclear Data Section**

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**Memo CP-D/1082**

**Date:** 27 April 2023

**To:** Distribution

**From:** N. Otsuka

**Subject: ZCHEX messages from EXFOR Master 2023-04-24 (NRDC 2023 A58)**

I received from Viktor Zerkin a full ZCHEX (Ver. 2023-04-24) error output from EXFOR Master Ver. 2023-04-11 and analysed it. For two messages on obsolete codes and illegal date (e.g., two-digit year), the number of entries having such problems is summarized in Appendix 1 without further analysis as they are legal until their next transmission. For other messages, I counted the number of entries and analysed the situations for the 10 most frequently appearing messages.

**1. Possible missing required keyword ERR-ANALYS**

Not very clear when ZCHEX prints this message. I would like to have this message when an uncertainty in the dependent variable (e.g., DATA-ERR) is coded without its definition under ERR-ANALYS (e.g., 10526.002). However, this message typically appears when any uncertainty is absent in the dataset (e.g., 10089.003) or NODATA is used (e.g., 10091.007). The Formats manual does not explain when it must be given, and this could be also responsible for the situation.

**Suggested conclusion for the Formats Manual “ERR-ANALYS”**

To revise the item 1 of the description to

Must be present with coded information when error fields associated to the dependent variable (e.g., DATA-ERR, ERR-S, ERR-1) are given. Otherwise, presence is optional and free text or coded information, with or without free text, may be given. Coded information is preferably not given for the error fields other than those associated to the dependent variable when its free text does not add information to the code expansion.

**Suggested action to ZCHEX:**

Update ZCHEX so that it prints this message only when an error field associated to the dependent variable is given without its definition under ERR-ANALYS.

**2. Incorrect units, should be dimension YLD Y-fld:DATA**

This comment appears when the dimension (“unit family”) of the quantity does not agree with the dimension of the unit code. The ZCHEX outputs from EXFOR Master are typically for one of the following cases:

* Combination of ,SPC (or ,SPC,,RES) with PRT/REAC. (e.g., 10053.053, 10065.006)

This combination is correct, but ZCHEX complains since these quantities are defined with YLD in Dictionary 236. MLT must replace YLD.

* Combination of ,ETA with (or ,ETA,,RES) with NO-DIM. (e.g., 10100.004)

This combination is wrong. The relevant entries must be revised (17 entries in area 1, 8 entries in area 2, 6 entries in area 4).

* Combination of ,ETA with (or ,ETA,,RES) with PRT/REAC. (e.g., 11310.013, 20917.032)

This combination is correct, but ZCHEX complains since these quantities are defined with YLD in Dictionary 236. MLT must replace YLD.

**Suggested action to NNDC, NEA DB and CJD:**

Retransmit η values coded with NO-DIM after its replacement with a correct unit code.

**Suggested action to myself:**

Replace the unit family code YLD with MLT for the quantities with SF6=SPC or ETA in Dict. 236.

**3. Illegal independent variable ENERGY**

This comment appears when EN (or its derivative) is coded for a quantity requiring a resonance energy EN-RES. (e.g., 10002.025, 10032.004). This is typically seen for average resonance parameters such as level spacing (,D) and strength function (,STF) for which EN-MIN/MAX-RES must replace EN-MIN/MAX. This combination is seen in area 1 (95 entries), 2 (52 entries), 3 (7 entries) and 4 (32 entries).

**4. Check use of heading THICKNESS**

This comment appears when THICKNESS is coded for a quantity which should not depend on the target thickness. When the neutron total cross section or capture cross section (,SIG) shows the thickness dependence and it is due to absence of corrections for sample effects (e.g., 21109.004), the compiler should check if the quantity is derived with thin target approximation (e.g., capture cross section ~ capture yield / areal sample density). If yes, addition of SF8=STA makes presence of THICKNESS legal. Otherwise move the thickness to free text under the keyword SAMPLE or add SF8=RAW.

**Suggested conclusion (reminder to compilers):**

THICKNESS is coded only when the quantity requires it as an independent variable.

**5. Illegal independent variable SEC.ENERGY**

This comment appears when secondary energy is coded for a quantity which does not require the secondary energy as an independent variable. I see two typical cases:

* presence of secondary energy is questionable, and the entry requires review and retransmission (e.g., 10919.002, 12800.006, 21054.069, 21086.004, 21105.002),
* level density (LD) which requires the excitation energy as a secondary energy, but ZCHEX complains because energy dependence is not indicated properly in Dict. 213 (e.g., 14184.003), (3) level density parameter (LDP) applicable for a particular excitation energy range (e.g, 20971.004).

**Suggested action to NDS:**

Introduce a new reaction type (say, NQE) for nuclear quantities requiring secondary energy such as the level density (LD).

**6. Incorrect units, should be dimension YLD Y-fld:DATA-ERR**

This comment usually appears with a similar comment for DATA. See my comment #3 above.

**7. Illegal code in field 4**

This comment appears when an unknown nuclide code is in REACTION SF4. There are three cases:

* a metastable state which presence was observed by the author but is currently unknown (e.g., 10142.002),
* a newly discovered nuclide which is still missing in the nuclide dictionary 227 (e.g., S0279.002),
* quasi-metastable state coded with -M instead -L (e.g., 10361.002).

We can ignore the messages for the first two case, but the isomeric flag must be corrected for the third case. I believe all such cases are included in Memo CP/D-1052 (Rev.) and registered in the Feedback List.

**Suggested action to NNDC, NDS, JCPRG, CNPD, CDFE:**

Correct the wrong isomeric flags listed in Memo CP-D/1052 (Rev.).

**8. Illegal code in field 7**

This comment is typically irrelevant to REACTION SF7 (e.g., E2339.020), and often appears when ZCHEX finds a problem under EN-SEC or MOM-SEC (e.g., when particle combination is defined as the particle considered under these keywords. See Case 10.).

***Example***:

 \*\* Illegal code in field 7

 \*\* End of code string not found 14055004

 EN-SEC (E,LF+HF) kinetic energy of fission fragment pairs 14055004

 ^^^^^

 \*\* Illegal code in field 7

 \*\* End of code string not found E2339020

 (E,ELEM) E2339020

 ^^^^

**Suggested action to ZCHEX:**

Update ZCHEX so that it prints an error message only when there is something wrong in REACTION SF7.

**9. End of code string not found**

This comment typically appears when a particle combination (particle codes connected by +) is defined under EN-SEC.

***Example:***

 \*\* End of code string not found A0848002

 EN-SEC (E-RL,N+T) A0848002

 ^^^

**Suggested action to ZCHEX:**

To update ZCHEX so that it recognizes a particle combination as a legal particle considered defined under EN-SEC etc.

**10. Missing code in field 4**

This comment appears when a nuclide code is missing in REACTION SF4. There are two typical cases:

* neutron scattering coded with REACTION SF3=EL, SCT or THS (e.g., 11205.004, 11511.003) for which the nuclide code in SF1 must be repeated in SF4.
* resonance parameters with a general quantity modifier (e.g., 21794.002, 23496.004, 40410.002).

**Suggested action to ZCHEX:**

Update ZCHEX so that it does not print this message when a resonance parameter is coded with a general quantity modifier in SF8.

**Appendix 1: Number of entries having obsolete codes and illegal date (e.g., two-digit years)**

|  |  |  |
| --- | --- | --- |
| **Area** | **Obsolete code** | **Illegal date** |
| 1 | 366 | 1728 |
| 2 | 266 | 1048 |
| 3 | 118 | 2 |
| 4 | 177 | 157 |
| A | 397 | 13 |
| B | 102 |  |
| C | 156 | 128 |
| D | 176 |  |
| E | 112 | 57 |
| F | 92 |  |
| G | 6 |  |
| K | 8 |  |
| L | 4 | 38 |
| M | 32 |  |
| O | 398 | 135 |
| P | 20 |  |
| R | 6 | 3 |
| S | 7 |  |
| T | 23 |  |
| V | 7 |  |

**Appendix 2: Number of error message appearance**

|  |  |  |
| --- | --- | --- |
|  | **Message** | **Entries** |
| 1 | Possible missing required keyword ERR-ANALYS | 214 |
| 2 | Incorrect units, should be dimension YLD Y-fld:DATA | 111 |
| 3 | Illegal independent variable ENERGY | 109 |
| 4 | Check use of heading THICKNESS | 90 |
| 5 | Illegal independent variable SEC.ENERGY | 83 |
| 6 | Incorrect units, should be dimension YLD Y-fld:DATA-ERR | 79 |
| 7 | Illegal code in field 4 | 51 |
| 8 | Illegal code in field 7 | 50 |
| 9 | End of code string not found | 50 |
| 10 | Missing code in field 4 | 44 |
| 11 | Missing independent variable NUCLIDE | 42 |
| 12 | Illegal code in field 1 | 42 |
| 13 | Illegal code field | 40 |
| 14 | Check use of heading TEMP | 36 |
| 15 | Missing data heading MASS | 31 |
| 16 | Multiply defined HEADING or FLAG | 27 |
| 17 | Check use of heading HL | 26 |
| 18 | Incorrect units, should be dimension FY Y-fld:DATA-ERR | 23 |
| 19 | Missing required keyword STATUS | 23 |
| 20 | Missing data heading ELEMENT | 23 |
| 21 | Possible missing required keyword TITLE | 23 |
| 22 | Illegal field identification for field 2 | 22 |
| 23 | METHOD,DETECTOR,ANALYSIS or FACILITY needed | 21 |
| 24 | Incorrect units, should be dimension MLT Y-fld:DATA | 19 |
| 25 | DG: Intensity without Energy | 18 |
| 26 | Missing independent variable ENERGY | 17 |
| 27 | Missing independent variable ANGLE | 17 |
| 28 | Missing data heading MASS 2 | 16 |
| 29 | Illegal independent variable ANGLE | 16 |
| 30 | REACTION fields 5-8 not in dictionary | 15 |
| 31 | Variable duplicated in subentry 1 ANGLE | 15 |
| 32 | Ind. var. link to REACTION not checked | 14 |
| 33 | Missing independent variable SEC.ENERGY | 14 |
| 34 | Incorrect units, should be dimension YLD Y-fld:ERR-S | 14 |
| 35 | Variable duplicated in subentry 1 SEC.ENERGY | 14 |
| 36 | Missing data heading MASS 1 | 13 |
| 37 | Outgoing particle sequence incorrect | 12 |
| 38 | Missing code field(s) | 12 |
| 39 | Illegal floating point number in field 2 | 12 |
| 40 | Missing data heading MONIT2 2 | 11 |
| 41 | Nucleus is stable | 11 |
| 42 | Incorrect units, should be dimension FY Y-fld:DATA | 11 |
| 43 | Incorrect units, should be dimension YLD Y-fld:DATA-MAX | 11 |
| 44 | Incorrect units, should be dimension B Y-fld:DATA-ERR | 10 |
| 45 | Nonmonatonic data field THICKNESS | 10 |
| 46 | Missing data heading MONIT 2 | 10 |
| 47 | Illegal independent variable RES.ENERGY | 10 |
| 48 | Incorrect units, should be dimension NO Y-fld:DATA | 10 |
| 49 | Incorrect units, should be dimension MAE Y-fld:DATA | 9 |
| 50 | Incorrect units, should be dimension MLT Y-fld:DATA-ERR | 9 |
| 51 | Missing data heading ELEMENT 2 | 9 |
| 52 | Incorrect units, should be dimension NO Y-fld:DATA-ERR | 9 |
| 53 | Missing data heading MONIT1 2 | 9 |
| 54 | Missing data heading FLAG 1 | 8 |
| 55 |  | 7 |
| 56 | Code too long | 7 |
| 57 | Incorrect units, should be dimension YLD Y-fld:ERR-T | 7 |
| 58 | Variable duplicated in subentry 1 ENERGY | 7 |
| 59 | Incorrect units, should be dimension THK X-fld:THICKNESS | 7 |
| 60 | Missing data heading ELEMENT 1 | 7 |
| 61 | Incorrect units, should be dimension B Y-fld:DATA | 7 |
| 62 | Incorrect units, should be dimension E Y-fld:DATA | 6 |
| 63 | Incorrect units, should be dimension E Y-fld:DATA-ERR | 6 |
| 64 | Incorrect units, should be dimension MLT Y-fld:ERR-T | 6 |
| 65 | Incorrect units, should be dimension NO X-fld:POL-BM-ERR | 6 |
| 66 | Missing data heading ASSUM 2 | 6 |
| 67 | Date out of legal range | 6 |
| 68 | Missing data heading MONIT1 | 6 |
| 69 | Input/output particles do not add up | 6 |
| 70 | Common1.ResPrm require SF5-8 reac-type RP=[.] in Dict-236 | 6 |
| 71 | Illegal code separator | 5 |
| 72 | Incorrect units, should be dimension NO Y-fld:ERR-T | 5 |
| 73 | Field value undefined FLAG | 5 |
| 74 | Missing data heading E | 5 |
| 75 | Missing data heading FLAG 2 | 5 |
| 76 | Expected Family Flag /vs.Dict-24/ LVL-INI:[E][ ] | 5 |
| 77 | Incorrect units, should be dimension YLD Y-fld:DATA-APRX | 5 |
| 78 | Incorrect units, should be dimension NO Y-fld:ERR-S | 5 |
| 79 | Incorrect units, should be dimension MDA Y-fld:DATA | 4 |
| 80 | Missing data heading FLAG 4 | 4 |
| 81 | Nonmonatonic data field E | 4 |
| 82 | Missing data heading MONIT2 | 4 |
| 83 | Nonmonatonic data field E-MIN | 4 |
| 84 | Missing data heading MONIT 1 | 4 |
| 85 | Expected Family Flag /vs.Dict-24/ LVL-FIN:[E][ ] | 4 |
| 86 | Incorrect units, should be dimension YLD Y-fld:+DATA-ERR | 3 |
| 87 | Nonmonatonic data field E2 | 3 |
| 88 | Missing data heading MONIT2 1 | 3 |
| 89 | Pointer not linked to REACTION or VCom 2 | 3 |
| 90 | Missing data heading MONIT3 | 3 |
| 91 | Nonmonatonic data field E-LVL | 3 |
| 92 | Incorrect units, should be dimension FY Y-fld:ERR-T | 3 |
| 93 | Dependent variable missing on record | 3 |
| 94 | Missing data heading E-LVL | 3 |
| 95 | Missing data heading FLAG 3 | 3 |
| 96 | Incorrect units, should be dimension YLD Y-fld:-DATA-ERR | 3 |
| 97 | Incorrect units, should be dimension MLT Y-fld:DATA-MAX | 3 |
| 98 | Incorrect units, should be dimension FY Y-fld:ERR-S | 3 |
| 99 | Heading not expected from REACTION EN-NM | 2 |
| 100 | Missing data heading MISC 1 | 2 |
| 101 | Nonmonatonic data field E-EXC-MIN | 2 |
| 102 | Incorrect units, should be dimension MLT Y-fld:ERR-DIG | 2 |
| 103 | Incorrect units, should be dimension B\*E Y-fld:ERR-T | 2 |
| 104 | Check use of heading GRP-NUM | 2 |
| 105 | Incorrect units, should be dimension DAE Y-fld:ERR-S | 2 |
| 106 | Missing independent variable OTHER | 2 |
| 107 | Incorrect units, should be dimension MAE Y-fld:ERR-T | 2 |
| 108 | Nonmonatonic data field ANG1 | 2 |
| 109 | Illegal independent variable NUCLIDE | 2 |
| 110 | Missing data heading MONIT1 1 | 2 |
| 111 | Missing data heading ASSUM 3 | 2 |
| 112 | Incorrect units, should be dimension DA Y-fld:ERR-S | 2 |
| 113 | Incorrect units, should be dimension DAE Y-fld:DATA | 2 |
| 114 | Missing data heading MONIT3 1 | 2 |
| 115 | Dict236.ResFlg conflicts with code in field 4 | 2 |
| 116 | Missing data heading LVL-NUMB | 2 |
| 117 | Incorrect units, should be dimension B\*E Y-fld:DATA-ERR | 2 |
| 118 | Missing data heading MONIT5 2 | 2 |
| 119 | Incorrect units, should be dimension DA Y-fld:DATA | 2 |
| 120 | Nonmonatonic data field ISOMER | 2 |
| 121 | Incorrect units, should be dimension DA Y-fld:DATA-ERR | 2 |
| 122 | Illegal leading blanks field 7 | 2 |
| 123 | Check use of heading HL-MIN | 2 |
| 124 | Missing data heading MONIT4 2 | 2 |
| 125 | Incorrect units, should be dimension NO Y-fld:ERR-SYS | 2 |
| 126 | Duplicate record | 2 |
| 127 | Nonmonatonic data field S | 2 |
| 128 | Missing required keyword REACTION | 2 |
| 129 | Nonmonatonic data field EN-MIN | 2 |
| 130 | Missing data heading MOM-SEC | 2 |
| 131 | Pointer not linked to REACTION or VCom R | 1 |
| 132 | Incorrect units, should be dimension 1/A Y-fld:DATA-ERR | 1 |
| 133 | Missing code for field 1 | 1 |
| 134 | Incorrect units, should be dimension DA Y-fld:ERR-T | 1 |
| 135 | Incorrect units, should be dimension BE2 Y-fld:DATA | 1 |
| 136 | Expected Family Flag /vs.Dict-24/ MOM-TR:[E][G] | 1 |
| 137 | Illegal DATA HEADING or UNIT | 1 |
| 138 | Expected Family Flag /vs.Dict-24/ E-NRM:[E][ ] | 1 |
| 139 | Expected Family Flag /vs.Dict-24/ LVL-INI2:[E][ ] | 1 |
| 140 | Pointer not linked to REACTION or VCom 1 | 1 |
| 141 | Nonmonatonic data field EN | 1 |
| 142 | Missing data heading MASS H | 1 |
| 143 | Missing data heading ELEMENT R | 1 |
| 144 | Missing data heading ASSUM2 5 | 1 |
| 145 | Missing data heading E-LVL-FIN | 1 |
| 146 | Incorrect units, should be dimension TIMEX-fld:ERR-HL | 1 |
| 147 | Nonmonatonic data field ANG-CM-MIN | 1 |
| 148 | Illegal character | 1 |
| 149 | No entries in COMMON Section for field 3 | 1 |
| 150 | Expected Family Flag /vs.Dict-24/ LVL-INI1:[E][ ] | 1 |
| 151 | Incorrect units, should be dimension BE2 Y-fld:DATA-ERR | 1 |
| 152 | Pointer not linked to REACTION or VCom B | 1 |
| 153 | Missing data heading ELEMENT L | 1 |
| 154 | Incorrect units, should be dimension MAE Y-fld:ERR-S | 1 |
| 155 | Pointer not linked to REACTION or VCom 3 | 1 |
| 156 | Heading not expected from REACTION EN-DUM-DN | 1 |
| 157 | Incorrect units, should be dimension NO Y-fld:DATA-ERR1 | 1 |
| 158 | Missing data heading ASSUM3 3 | 1 |
| 159 | Incorrect units, should be dimension E Y-fld:-DATA-ERR | 1 |
| 160 | Incorrect units, should be dimension BRE Y-fld:DATA | 1 |
| 161 | Missing data heading E-LVL-NM 1 | 1 |
| 162 | Missing data heading MONIT4 | 1 |
| 163 | Missing data heading ASSUM1 | 1 |
| 164 | Missing data heading MASS R | 1 |
| 165 | Nonmonatonic data field ELEMENT | 1 |
| 166 | Incorrect units, should be dimension B Y-fld:+DATA-ERR | 1 |
| 167 | Expected Family Flag /vs.Dict-24/ LVL:[E][ ] | 1 |
| 168 | Incorrect units, should be dimension E X-fld:KT-ERR | 1 |
| 169 | Incorrect units, should be dimension E Y-fld:DATA-MAX | 1 |
| 170 | Incorrect units, should be dimension YLD Y-fld:ERR-SYS | 1 |
| 171 | Heading not expected from REACTION EN-DN | 1 |
| 172 | Incorrect units, should be dimension E X-fld:E-EXC-C-MX | 1 |
| 173 | Incorrect units, should be dimension YLD Y-fld:DATA-MIN | 1 |
| 174 | Expected Family Flag /vs.Dict-24/ ANG1:[E][G] | 1 |
| 175 | Incorrect units, should be dimension YDA Y-fld:DATA-ERR | 1 |
| 176 | Missing data heading ELEMENT H | 1 |
| 177 | Incorrect units, should be dimension NO X-fld:POL-TR-ERR | 1 |
| 178 | Incorrect units, should be dimension TTY Y-fld:DATA | 1 |
| 179 | Incorrect units, should be dimension MDA Y-fld:ERR-T | 1 |
| 180 | Incorrect units, should be dimension B Y-fld:-DATA-ERR | 1 |
| 181 | Missing data heading MASS L | 1 |
| 182 | Missing data heading ASSUM1 4 | 1 |
| 183 | Missing data heading MISC 2 | 1 |
| 184 | Missing data heading MONIT3 3 | 1 |
| 185 | Heading not expected from REACTION EN-RES-NM | 1 |
| 186 | Incorrect units, should be dimension E X-fld:E-LVL | 1 |
| 187 | Nonmonatonic data field LVL-NUMB | 1 |
| 188 | Missing data heading E2 | 1 |
| 189 | Expected Family Flag /vs.Dict-24/ LVL-FIN2:[E][ ] | 1 |
| 190 | Incorrect units, should be dimension E Y-fld:+DATA-ERR | 1 |
| 191 | Missing data heading ASSUM2 | 1 |
| 192 | Expected Family Flag /vs.Dict-24/ ANG2:[E][G] | 1 |
| 193 | Missing data heading FLAG 5 | 1 |
| 194 | Missing data heading E1 | 1 |
| 195 | Expected Family Flag /vs.Dict-24/ E-RSL:[E][F] | 1 |
| 196 | Incorrect units, should be dimension MDA Y-fld:ERR-DIG | 1 |
| 197 | Incorrect units, should be dimension DA Y-fld:-DATA-ERR | 1 |
| 198 | Incorrect units, should be dimension DA Y-fld:+DATA-ERR | 1 |
| 199 | Missing data heading MONIT2 3 | 1 |
| 200 | Check use of heading HL1 | 1 |
| 201 | Incorrect units, should be dimension L Y-fld:DATA-ERR | 1 |
| 202 | Missing data heading MONIT | 1 |
| 203 | Missing data heading MONIT1 3 | 1 |
| 204 | Incorrect units, should be dimension NO X-fld:ERR-IDD | 1 |
| 205 | Incorrect units, should be dimension YDA Y-fld:DATA | 1 |
| 206 | Missing data heading E-LVL-DN 1 | 1 |
| 207 | Heading not expected from REACTION MONIT-DN | 1 |
| 208 | Heading not expected from REACTION MONIT-NM | 1 |
| 209 | Missing data heading E-LVL 2 | 1 |
| 210 | Heading not expected from REACTION EN-RES-DN | 1 |
| 211 | Incorrect units, should be dimension FY Y-fld:ERR-1 | 1 |
| 212 | Incorrect units, should be dimension NO Y-fld:ERR-DIG | 1 |
| 213 | Nonmonatonic data field EN-MAX | 1 |
| 214 | Missing data heading ASSUM2 2 | 1 |
| 215 | Expected Family Flag /vs.Dict-24/ LVL-FIN1:[E][ ] | 1 |
| 216 | Incorrect units, should be dimension YLD Y-fld:ERR-1 | 1 |
| 217 | Incorrect units, should be dimension FYDEY-fld:ERR-DIG | 1 |

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