

JEF-Doc-302
May 1990

STATUS REPORT ON THE NI EVALUATION FOR JEF-2

-Contribution to JEF meeting, May 30-31, 1990, Saclay-

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1. Ni-evaluation /ref.[1]/.

The evaluation of Ni-isotopes has been completed and the file has been tested against formatting and physical errors. The evaluation of the major isotopes (Ni-58,60) consists of the following contributions:

- 1.The resolved resonance region upto about 550 keV is based on the evaluation of Derrien et al. and was inserted by NEA Data Bank in MF=2.
- 2.Smooth cross-sections (MF=3: MT=1,2,3,102,103,107), elastic scattering angular distributions (MT=4) and photon-production spectra (MF=12,14,15; MT=102) below 1 MeV are based on calculations performed at the ECN with codes SASSI-ECN and GNASH.
- 3.The radiative capture cross-section (MF=3; MT=102) in the energy range 550 keV to 20 MeV was calculated with the code SASSI-ECN.
- 4.All other data (in MF=3,4,6,12,14,15) above $E_n > 1$ MeV originate from the calculations of Uhl (IRK) performed with the code MAURINA.

Note: Deviations from ENDF-6 rules:

1. The data for continuum particle-emission reactions are given without energy angle distributions separately, these data have been lumped into the quantity MT=10. It contains distributions for neutrons, protons, alpha particles and recoiling nuclei. For the calculation of a neutron transport group cross-section library only the quantities MT=1,2,10,51-90 and 102 need to be processed [2].
2. Photon-production spectra are stored, due to the original output format of MAURINA, in the following way: below 1 MeV the quantity MT=102 represents the photon production, while for high-energy range (>1 MeV) all data are lumped under MT=3. The rather artificial splitting of photon production data into a part at $E < 1$ MeV (MT=102) and a part at $E > 1$ MeV was made to facilitate selfshielding calculations of the radiative capture cross-sections at $E < 1$ MeV. For the calculation of a neutron-photon coupled group cross-section library only the quantities MT=1,2,3,10,51-90 and 102 need to be processed [2].

The detailed structure of both files is given in Appendix 1.

A separate document on the processing of Ni data file was given in Ref. [2].

For minor stable isotopes (Ni-61,62,64) the JENDL-2 evaluation has been adopted with two replacements:

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1. The resolved-resonance parameters of Derrien et al. have been inserted by the NEA Data Bank.
2. For photon-production spectra, missing in JENDL-2, files MF=12,14 and 15 for Ni-60 have been used in combination with MT=3 and 102.

Cross-sections for the long-lived isotope Ni-59 have been derived from the KEDAK library and from the activation file REAC-ECN-4, based on the renormalized THRES calculations. This file was assembled at the NEA Data Bank.

2. Covariance data

The Ni data file will be supplemented with covariance data in the frame of the EFF project. This work is in progress.

3. References:

- [1] H. Gruppelaar, H.A.J. van der Kamp, J. Kopecky, D. Nierop and M. Uhl, "Evaluation of Neutron Cross-Sections and Photon-Production Data for Ni-58 and Ni-60 isotopes in the Energy Range 0-20 MeV", JEF/EFF-DOC (1990) ..., ECN-REPORT ECN-90-..., to be published.
- [2] H. Gruppelaar, Note on the processing of the EFF data library, EFF-Doc-46 (May 1990).

28-NI- 58	ECN/IRK/NDB EVAL-H.GRUPPELAAR, V.D.KAMP, J.KOPECKY,	2825 1451	5
	D.NIEROP (ECN)	2825 1451	6
-----JEF-2	MATERIAL 2825 REVISION O	2825 1451	7
-----INCIDENT NEUTRON DATA		2825 1451	8
-----ENDF-6 FORMAT		2825 1451	9
	M.UHL (IRK)	2825 1451	10
JEF-DOC	DIST-JUNE90	2825 1451	11
----JEF-2/EFF-2	MATERIAL 2825	2825 1451	12
-----INCIDENT NEUTRON DATA		2825 1451	13
-----ENDF-6 FORMAT		2825 1451	14
*****		2825 1451	15
HISTORY		2825 1451	16
		2825 1451	17
87-10 -NEW EVALUATION AT E > 1 MEV WAS MADE BY M. UHL (IRK-VIENNA)		2825 1451	18
SEE REF. /1/		2825 1451	19
88-04 -DERRIEN'S RESONANCE PARAMETERS /2/ INSERTED (NEA DATA BANK)		2825 1451	20
88-04 -REFORMATTING OF IRK-EVALUATION (ECN)		2825 1451	21
-REEVALUATION OF (N,GAMMA) CROSS-SECTION (ECN)		2825 1451	22
-SMOOTH BACKGROUND ADDED IN RESOLVED RESONANCE RANGE (ECN)		2825 1451	23
-EVALUATION OF CROSS-SECTIONS ABOVE RESOLVED RESONANCE RANGE		2825 1451	24
UPTO 1 MEV (ECN)		2825 1451	25
89-11 -RECOIL SPECTRA OF IRK ADDED (ECN)		2825 1451	26
90-03 -PHOTON-PRODUCTION DATA OF IRK ADDED		2825 1451	27
-CALCULATION OF (N,G) SPECTRA BELOW 1 MEV (ECN)		2825 1451	28
90-05 -FINAL EVALUATION ISSUED /3/		2825 1451	29
*****		2825 1451	30
		2825 1451	31
THIS WORK EMPLOYED NUCLEAR MODEL CODES MAURINA /4/, GNASH /5/		2825 1451	32
AND SASSI-ECN /6/. DETAILS PERTINENT TO THE CONTENTS OF THIS		2825 1451	33
EVALUATION AND COMPARISON OF CALCULATIONS WITH EXPERIMENTAL		2825 1451	34
DATA CAN BE FOUND IN REF. /3/. ALL EVALUATIONS ABOVE 1 MEV WERE		2825 1451	35
CALCULATED WITH THE CODE MAURINA AT IRK, EXCEPT MT=102 WHICH		2825 1451	36
WAS CALCULATED AT ECN WITH SASSI-ECN. DATA BETWEEN THE RESOLVED		2825 1451	37
RESONANCE REGION (EH=0.550 MEV) AND 1 MEV WERE SUPPLEMENTED BY		2825 1451	38
ECN FROM SASSI-ECN CALCULATIONS (MT=2,3,102), TRESH-ESTIMATES		2825 1451	39
(MT=103,107) IN MF=3,4 /7/ AND GNASH CALCULATIONS (MT=102) IN		2825 1451	40
MF=12 AND 15. FOR FIRST-CHANCE PARTICLE EMISSION THE FOLLOWING		2825 1451	41
CONTRIBUTIONS ARE ACCOUNTED FOR IN THE CODE MAURINA:		2825 1451	42
		2825 1451	43
1) HAUSER-FESHBACH MODEL WITH ANGULAR DISTRIBUTION FOR ALL LEVELS		2825 1451	44
(LMAX=4) .		2825 1451	45
2) EXCITON MODEL WITH ANGULAR DISTRIBUTIONS ACCORDING TO THE KAL-		2825 1451	46
BACH-MANN SYSTEMATICS.		2825 1451	47
3) DWBA, FOR COLLECTIVE LEVELS EXCITED BY INELASTIC SCATTERING.		2825 1451	48
*****		2825 1451	49
		2825 1451	50
NOTE: DEVIATION FROM ENDF-VI RULES:		2825 1451	51
THE DATA TYPES MT=16,22,28,91,106,108,111,112,649,849 ARE		2825 1451	52
GIVEN WITHOUT ENERGY-ANGLE DISTRIBUTIONS. HOWEVER, THESE		2825 1451	53
DATA TYPES HAVE BEEN LUMPED INTO THE QUANTITY MT=10 WHICH		2825 1451	54
CONTAINS ENERGY-ANGLE DISTRIBUTIONS FOR NEUTRONS, PROTONS,		2825 1451	55
ALPHA PARTICLES AND RECOILING NUCLEI.		2825 1451	56
FOR THE CALCULATION OF NEUTRON AND PHOTON GROUP-TRANSFER		2825 1451	57
MATRICES FOR TRANSPORT CALCULATIONS ONLY THE DATA TYPES		2825 1451	58
MT=1,2,3,10,51-71 AND 102 ARE REQUIRED. NEUTRON		2825 1451	59
DISTRIBUTIONS ARE GIVEN FOR MT=2,10,51-71. IF THE NJOY CODE		2825 1451	60
IS USED ONLY THESE MT NUMBERS SHOULD BE SPECIFIED.		2825 1451	61
*****		2825 1451	62
		2825 1451	63
----- DESCRIPTION OF FILES		2825 1451	64

(MF - MT)		2825 1451	65
		2825 1451	66
1 - 451	HISTORY OF EVALUATION, GENERAL INFORMATION AND DEFINITIONS	2825 1451	67
		2825 1451	68
2 - 151	RESONANCE PARAMETERS (MULTI-LEVEL BREIT-WIGNER FORMALISM) ARE USED TO PROVIDE THE TOTAL, SCATTERING AND CAPTURE CROSS-SECTIONS FROM 1.E-5 EV UPTO 550 KEV.	2825 1451	69
	SMOOTH BACKROUND WAS ADDED IN THIS RANGE TO ACCOUNT FOR MISSED RESONANCES AND STORED IN MT=1,3 AND 102.	2825 1451	70
	THE RESONANCE PARAMETERS ARE TAKEN FROM THE ANALYSIS OF TRANSMISSION, SCATERING AND CAPTURE DATA /2,3/.	2825 1451	71
	NEGATIVE RESONANCE PARAMETERS HAVE BEEN ADDED (ECN) TO REPRODUCE THE CORRECT THERMAL VALUES.	2825 1451	72
		2825 1451	73
3 - 1	THE TOTAL CROSS-SECTION WAS OBTAINED FROM 0.550 TO 20 MEV BY ADDING THE ELASTIC AND NONELASTIC CROSS-SECTIONS.	2825 1451	74
		2825 1451	75
3 - 2	THE ELASTIC CROSS-SECTION WAS CALCULATED WITH SASSI-ECN (<1 MEV) AND MAURINA (1-20 MEV) AND SMOOTHLY JOINED AROUND 1 MEV.	2825 1451	76
		2825 1451	77
3 - 3	NON-ELASTIC CROSS-SECTION WITH SMOOTH BACKROUND IN THE RESOLVED RESONANCE REGION; SUM OF 3-4, 3-16, 3-22, 3-28, 3-102, 3-103 AND 3-107.	2825 1451	78
		2825 1451	79
3 - 4	TOTAL INELASTIC CROSS-SECTION; SUM OF 3-51, 3-52, 3-71 AND 3-91.	2825 1451	80
		2825 1451	81
3 - 10	TOTAL CONTINUUM PARTICLE EMISSION CROSS-SECTIONS (LUMPED SUM OF 3-16, 3-22, 3-28, 3-91, 3-106, 3-108, 3-111, 3-112, 3-649, 3-849).	2825 1451	82
		2825 1451	83
3 - 16	(N,2N) CROSS-SECTION.	2825 1451	84
3 - 22	(N,NA) + (N,AN) CROSS-SECTIONS.	2825 1451	85
3 - 28	(N,NP) + (N,PN) CROSS-SECTIONS.	2825 1451	86
3 - 51-71	INELASTING SCATTERING EXCITING DISCRETE LEVELS; DIRECT INTERACTION CROSS-SECTIONS INCLUDED (DWBA CALCULATIONS).	2825 1451	87
		2825 1451	88
3 - 91	INELASTIC SCATTERING EXCITING CONTINUUM.	2825 1451	89
3 - 102	(N,G) CROSS-SECTION CALCULATED WITH STATISTICAL MODEL + DIRECT-SEMIDIRECT TERM (SASSI-ECN) FROM 550 KEV UPTO 20 MEV. FROM 1.E-5 EV UPTO 550 KEV THE CROSS SECTION IS PROVIDED BY RESONANCE PARAMETERS (2-151). A SMALL SMOOTH BACKROUND IS PROVIDED TO ACCOUNT FOR MISSED RESONANCES. FROM 0.5 - 1.5 MEV THE AVERAGE CAPTURE DATA WERE USED FOR NORMALIZATION.	2825 1451	90
		2825 1451	91
3 - 103	(N,P) CROSS-SECTIONS; SUM OF 3-600, 3-601, ..., 3-608 AND 3-649.	2825 1451	92
		2825 1451	93
3 - 106	(N,3-HE) CROSS-SECTIONS.	2825 1451	94
3 - 107	(N,A) CROSS-SECTIONS; SUM OF 3-800, 3-801,, 3-808 AND 3-849.	2825 1451	95
		2825 1451	96
3 - 108	(N,2A) CROSS-SECTIONS.	2825 1451	97
3 - 111	(N,2P) CROSS-SECTIONS.	2825 1451	98
3 - 112	(N,PA) CROSS-SECTIONS.	2825 1451	99
3 - 600-608	(N,P) CROSS-SECTIONS EXCITING DISCRETE LEVELS.	2825 1451	100
3 - 649	(N,P) CROSS-SECTIONS TO CONTINUUM.	2825 1451	101
3 - 800-808	(N,A) CROSS-SECTIONS EXCITING DISCRETE LEVELS.	2825 1451	102
3 - 849	(N,A) CROSS-SECTIONS TO CONTINUUM.	2825 1451	103
4 - 2	ANGULAR DISTRIBUTIONS OF SECONDARY NEUTRONS FOR ELASTIC SCATTERING (BELOW 1 MEV; FROM SASSI-ECN, CALCULATIONS BY THE MAURINA CODE ABOVE 1 MEV). LEGENDRE POLYNOMIAL REPRESENTATION IN CM - SYSTEM. NO TRANSFORMATION MATRIX IS GIVEN.	2825 1451	104
		2825 1451	105
4 - 51-71	ANGULAR DISTRIBUTIONS OF SECONDARY NEUTRONS FROM SCATTERING TO DISCRETE LEVELS.	2825 1451	106
		2825 1451	107
		2825 1451	108
		2825 1451	109
		2825 1451	110
		2825 1451	111
		2825 1451	112
		2825 1451	113
		2825 1451	114
		2825 1451	115
		2825 1451	116
		2825 1451	117
		2825 1451	118
		2825 1451	119
		2825 1451	120
		2825 1451	121
		2825 1451	122
		2825 1451	123
		2825 1451	124

4 - 601-608	ANGULAR DISTRIBUTIONS OF PROTONS EXCITING DISCRETE LEVELS.	2825 1451 125
		2825 1451 126
4 - 801-808	ANGULAR DISTRIBUTIONS OF ALPHA'S EXCITING DISCRETE LEVELS.	2825 1451 127
		2825 1451 128
6 - 10	TOTAL ENERGY-ANGLE DISTRIBUTIONS OF LIGHT AND HEAVY REACTION PRODUCTS EXCEPT PHOTONS EMITTED INTO THE CONTINUUM: N, P, ALPHA, 51CR, 54MN, 54FE, 55FE, 56FE, 57FE, 57CO, 58CO, 57NI, 58NI, 59NI. EACH SECTION INCLUDES ENERGY DEPENDENT YIELDS AND NORMALIZED ENERGY-ANGLE DISTRIBUTIONS.	2825 1451 129
		2825 1451 130
		2825 1451 131
		2825 1451 132
		2825 1451 133
		2825 1451 134
12 - 3	MULTIPLICITIES FOR LUMPED PHOTON PRODUCTION ABOVE 1 MEV (CALCULATED BY THE CODE MAURINA).	2825 1451 135
		2825 1451 136
12 - 102	MULTIPLICITIES FOR (N,G) REACTION (CALCULATED BY THE GNASH CODE) UPTO 1 MEV.	2825 1451 137
		2825 1451 138
14 - 3	ANGULAR DISTRIBUTION OF PHOTONS ASSUMMED ISOTROPIC IN CM SYSTEM.	2825 1451 139
		2825 1451 140
14 - 102	ANGULAR DISTRIBUTION OF PHOTONS ASSUMMED ISOTROPIC IN CM SYSTEM.	2825 1451 141
		2825 1451 142
15 - 3	NORMALIZED ENERGY DISTRIBUTIONS FOR LUMPED PHOTON PRODUCTION ABOVE 1 MEV (CALCULATED WITH MAURINA).	2825 1451 143
		2825 1451 144
15 - 102	NORMALIZED ENERGY DISTRIBUTIONS FOR THE (N,G) REACTION BELOW 1 MEV (CALCULATED WITH GNASH).	2825 1451 145
		2825 1451 146
		2825 1451 147
		2825 1451 148
----- REFERENCES		
/1/	-B. STROHMAIER, M. UHL AND W. REITER, PROC. ADV. GROUP MEETING ON NUCLEAR DATA FOR RADIATION DAMAGE ASSESMENT AND RELATED SAFETY ASPECTS, VIENNA 1981, IAEA-TECDOC-263, P. 135.	2825 1451 149
		2825 1451 150
		2825 1451 151
	-B. STROHMAIER AND M. UHL, PROC. INT. CONFERENCE FOR SCIENCE AND TECHNOLOGY, ANTWERP (1982), (REIDEL, DORDRECHT 1983) 361.	2825 1451 152
		2825 1451 153
	-M. UHL, NUCL. SCI. ENG. (1988).	2825 1451 154
	-M. UHL, PRIVATE COMMUNICATION.	2825 1451 155
/2/	H. DERRIEN AND D. LAFOND, NOTE TECHNIQUE, CEA, 1985.	2825 1451 156
/3/	H. GRUPPELAAR, H. V.D. KAMP, J. KOPECKY, D. NIEROP AND M. UHL, "EVALUATION OF NEUTRON CROSS-SECTIONS AND PHOTON-PRODUCTION DATA FOR NI-ISOTOPES IN THE ENERGY RANGE 0 - 20 MEV", JEF-DOC (1990), ECN-REPORT, ECN-90.	2825 1451 157
		2825 1451 158
		2825 1451 159
		2825 1451 160
/4/	M. UHL, UNPUBLISHED.	2825 1451 161
/5/	P.G. YOUNG AND E.D. ARTHUR, "GNASH - A PREEQUILIBRIUM STATISTICAL MODEL CODE FOR CALCULATION OF CROSS-SECTIONS AND EMISSION SPECTRA", LOS ALAMOS REPORT, LA-6947 (1977), RECENT VERSION RECEIVED FROM AUTHORS.	2825 1451 162
		2825 1451 163
		2825 1451 164
		2825 1451 165
/6/	H. GRUPPELAAR AND R. VENNINK, SASSI-ECN, UNPUBLISHED.	2825 1451 166
/7/	H. GRUPPELAAR, H.A.J. VAN DER KAMP, J. KOPECKY AND D. NIEROP, "THE REAC-ECN-3 DATA LIBRARY WITH NEUTRON ACTIVATION AND TRANS MUTATION CROSS-SECTIONS FOR USE IN FUSION REACTOR TECHNOLOGY", ECN-REPORT, ECN-207 (1988).	2825 1451 167
		2825 1451 168
		2825 1451 169
		2825 1451 170
	*****	2825 1451 171

28-NI- 60	ECN/IRK/NDB EVAL-H.GRUPPELAAR, V.D.KAMP, J.KOPECKY,	2831	1451	5
	D.NIEROP (ECN)	2831	1451	6
-----JEF-2	MATERIAL 2831 REVISION O	2831	1451	7
-----INCIDENT NEUTRON DATA		2831	1451	8
-----ENDF-6 FORMAT		2831	1451	9
	M.UHL (IRK)	2831	1451	10
JEF-DOC	DIST-JUNE90	2831	1451	11
-----JEF-2/EFF-2	MATERIAL 2831	2831	1451	12
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-----ENDF-6 FORMAT		2831	1451	14
*****		2831	1451	15
HISTORY		2831	1451	16
		2831	1451	17
87-10 -NEW EVALUATION AT E > 1 MEV WAS MADE BY M. UHL (IRK-VIENNA)		2831	1451	18
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88-04 -DERRIEN'S RESONANCE PARAMETERS /2/ INSERTED (NEA DATA BANK)		2831	1451	20
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		2831	1451	63
----- DESCRIPTION OF FILES		2831	1451	64

(MF - MT)		2831 1451	65
		2831 1451	66
1 - 451	HISTORY OF EVALUATION, GENERAL INFORMATION AND DEFINITIONS	2831 1451	67
		2831 1451	68
2 - 151	RESONANCE PARAMETERS (MULTI-LEVEL BREIT-WIGNER FORMALISM) ARE USED TO PROVIDE THE TOTAL, SCATTERING AND CAPTURE CROSS-SECTIONS FROM 1.E-5 EV UPTO 550 KEV.	2831 1451	69
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3 - 1	THE TOTAL CROSS-SECTION WAS OBTAINED FROM 0.550 TO 20 MEV BY ADDING THE ELASTIC AND NONELASTIC CROSS-SECTIONS.	2831 1451	74
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3 - 2	THE ELASTIC CROSS-SECTION WAS CALCULATED WITH SASSI-ECN (<1 MEV) AND MAURINA (1-20 MEV) AND SMOOTHLY JOINED AROUND 1 MEV.	2831 1451	76
		2831 1451	77
3 - 3	NON-ELASTIC CROSS-SECTION WITH SMOOTH BACKROUND IN THE RESOLVED RESONANCE REGION; SUM OF 3-4, 3-16, 3-22, 3-28, 3-102, 3-103 AND 3-107.	2831 1451	78
		2831 1451	79
3 - 4	TOTAL INELASTIC CROSS-SECTION; SUM OF 3-51, 3-52, 3-76 AND 3-91.	2831 1451	80
		2831 1451	81
3 - 10	TOTAL CONTINUUM PARTICLE EMISSION CROSS-SECTIONS (LUMPED SUM OF 3-16, 3-22, 3-28, 3-91, 3-106, 3-111, 3-112, 3-649, 3-849).	2831 1451	82
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3 - 16	(N,2N) CROSS-SECTION.	2831 1451	84
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		2831 1451	88
3 - 91	INELASTIC SCATTERING EXCITING CONTINUUM.	2831 1451	89
3 - 102	(N,G) CROSS-SECTION CALCULATED WITH STATISTICAL MODEL + DIRECT-SEMIDIRECT TERM (SASSI-ECN) FROM 550 KEV UPTO 20 MEV. FROM 1.E-5 EV UPTO 550 KEV THE CROSS SECTION IS PROVIDED BY RESONANCE PARAMETERS (2-151). A SMALL SMOOTH BACKROUND IS PROVIDED TO ACCOUNT FOR MISSED RESONANCES. FROM 0.5 - 1.5 MEV THE AVERAGE CAPTURE DATA WERE USED FOR NORMALIZATION.	2831 1451	90
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		2831 1451	96
3 - 111	(N,2P) CROSS-SECTIONS.	2831 1451	97
3 - 112	(N,PA) CROSS-SECTIONS.	2831 1451	98
3 - 600-611	(N,P) CROSS-SECTIONS EXCITING DISCRETE LEVELS.	2831 1451	99
3 - 649	(N,P) CROSS-SECTIONS TO CONTINUUM.	2831 1451	100
3 - 800-819	(N,A) CROSS-SECTIONS EXCITING DISCRETE LEVELS.	2831 1451	101
3 - 849	(N,A) CROSS-SECTIONS TO CONTINUUM.	2831 1451	102
4 - 2	ANGULAR DISTRIBUTIONS OF SECONDARY NEUTRONS FOR ELASTIC SCATTERING (BELOW 1 MEV; FROM SASSI-ECN, CALCULATIONS BY THE MAURINA CODE ABOVE 1 MEV). LEGENDRE POLYNOMIAL REPRESENTATION IN CM - SYSTEM. NO TRANSFORMATION MATRIX IS GIVEN.	2831 1451	103
		2831 1451	104
4 - 51-76	ANGULAR DISTRIBUTIONS OF SECONDARY NEUTRONS FROM SCATTERING TO DISCRETE LEVELS.	2831 1451	105
		2831 1451	106
4 - 601-611	ANGULAR DISTRIBUTIONS OF PROTONS EXCITING DISCRETE	2831 1451	107

	LEVELS.	2831	1451	125
4 - 801-819	ANGULAR DISTRIBUTIONS OF ALPHA'S EXCITING DISCRETE LEVELS.	2831	1451	126
		2831	1451	127
6 - 10	TOTAL ENERGY-ANGLE DISTRIBUTIONS OF LIGHT AND HEAVY REACTION PRODUCTS EXCEPT PHOTONS EMITTED INTO THE CONTINUUM: N, P, ALPHA, 56MN, 56FE, 57FE, 58FE, 59FE, 59CO, 60CO, 59NI, 60NI, 61NI. EACH SECTION INCLUDES ENERGY DEPENDENT YIELDS AND NORMALIZED ENERGY-ANGLE DISTRIBUTIONS.	2831	1451	128
		2831	1451	129
		2831	1451	130
		2831	1451	131
		2831	1451	132
		2831	1451	133
12 - 3	MULTIPLICITIES FOR LUMPED PHOTON PRODUCTION ABOVE 1 MEV (CALCULATED BY THE CODE MAURINA).	2831	1451	134
		2831	1451	135
12 - 102	MULTIPLICITIES FOR (N,G) REACTION (CALCULATED BY THE GNASH CODE) UPTO 1 MEV.	2831	1451	136
		2831	1451	137
14 - 3	ANGULAR DISTRIBUTION OF PHOTONS ASSUMED ISOTROPIC IN CM SYSTEM.	2831	1451	138
		2831	1451	139
14 - 102	ANGULAR DISTRIBUTION OF PHOTONS ASSUMED ISOTROPIC IN CM SYSTEM.	2831	1451	140
		2831	1451	141
15 - 3	NORMALIZED ENERGY DISTRIBUTIONS FOR LUMPED PHOTON PRODUCTION ABOVE 1 MEV (CALCULATED WITH MAURINA).	2831	1451	142
		2831	1451	143
15 - 102	NORMALIZED ENERGY DISTRIBUTIONS FOR THE (N,G) REACTION BELOW 1 MEV (CALCULATED WITH GNASH).	2831	1451	144
		2831	1451	145
		2831	1451	146
		2831	1451	147
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		2831	1451	157
		2831	1451	158
		2831	1451	159
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		2831	1451	163
		2831	1451	164
/6/	H. GRUPPELAAR AND R. VENNINK, SASSI-ECN, UNPUBLISHED.	2831	1451	165
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		2831	1451	167
		2831	1451	168
		2831	1451	169
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28-NI- 59	NDB/ECN EVAL-H.GRUPPELAAR, H.V.D.KAMP, J.KOPECKY,	2828 1451	5
	D.NIEROP (ECN)	2828 1451	6
-----JEF-2	MATERIAL 2828	2828 1451	7
-----INCIDENT NEUTRON DATA		2828 1451	8
-----ENDF-6 FORMAT		2828 1451	9
HISTORY		2828 1451	10
89-01	EVALUATION COMPILED AT THE NEA DATA BANK.	2828 1451	11
90-01	PHOTON PRODUCTION ADDED (ECN). DATA FROM THE 60-NI JEF-2	2828 1451	12
	EVALUATION USED AS AN ESTIMATE (SEE REF. /1/).	2828 1451	13
		2828 1451	14
MF=2		2828 1451	15
MT=151	RESONANCE PARAMETERS TAKEN FROM BNL-325 (4TH ED.)	2828 1451	16
		2828 1451	17
MF=3		2828 1451	18
MT=1	BACKGROUND CROSS SECTION IN THE RESONANCE REGION TAKEN	2828 1451	19
	FROM THE SUM OF MT=103 AND MT=107, AS TWO COMPETITIVE	2828 1451	20
	ARE NOT ALLOWED IN THE ENDF FORMAT.	2828 1451	21
	THE HIGH ENERGY REGION WAS CONSTRUCTED AS THE SUM OF	2828 1451	22
	ALL PARTIAL CROSS SECTIONS.	2828 1451	23
MT=2	HIGH ENERGY REGION GIVEN AS A STRAIGHT LINE BETWEEN THE	2828 1451	24
	VALUE AT THE END OF THE RESONANCE REGION (13 B) AND AN	2828 1451	25
	ESTIMATED VALUE OF 1 BARN AT 20 MEV.	2828 1451	26
MT=103	TAKEN FROM KEDAK4.	2828 1451	27
MT=107	TAKEN FROM KEDAK4.	2828 1451	28
	ALL OTHER CROSS SECTIONS TAKEN FROM THE ACTIVATION LIB.	2828 1451	29
	REAC-ECN-4.	2828 1451	30
MF=4		2828 1451	31
MT=2	TAKEN FROM NI-61 EVALUATION OF JENDL-2	2828 1451	32
	ALL OTHER ANGULAR DISTRIBUTIONS ASSUMED TO BE ISOTROPIC	2828 1451	33
		2828 1451	34
		2828 1451	35
MF=12	PHOTON MULTIPLICITIES	2828 1451	36
MT=3	LUMPED PHOTON PRODUCTION ABOVE 1 MEV (MAURINA CODE)	2828 1451	37
MT=102	(N,G) REACTION BELOW 1 MEV (GNASH CODE)	2828 1451	38
		2828 1451	39
MF=14	ANGULAR DISTRIBUTIONS	2828 1451	40
MT=3,102	ASSUMED ISOTROPIC IN CM SYSTEM	2828 1451	41
		2828 1451	42
MF=15	ENERGY DISTRIBUTION	2828 1451	43
MT=3	NORMALIZED ENERGY DISTRIBUTIONS (EN > 1 MEV).	2828 1451	44
MT=102	NORMALIZED ENERGY DISTRIBUTIONS (EN < 1 MEV).	2828 1451	45
		2828 1451	46
REFERENCES:		2828 1451	47
/1/	H. GRUPPELAAR, H. V.D. KAMP, J. KOPECKY, D. NIEROP AND	2828 1451	48
	M. UHL, "EVALUATION OF NEUTRON CROSS-SECTIONS AND	2828 1451	49
	PHOTON-PRODUCTION DATA FOR NI-ISOTOPES IN THE ENERGY RANGE	2828 1451	50
	0 - 20 MEV", JEF-DOC (1990), ECN-REPORT, ECN-90.	2828 1451	51

28-NI- 61 JEF-2	RCOM-NOV87 GRUPPELAAR, VD.KAMP, KOPECKY, NIEROP	2834 1451	5
	DIST-DEC88	2834 1451	6
----JEF-2	MATERIAL 2834	2834 1451	7
-----INCIDENT NEUTRON DATA		2834 1451	8
-----ENDF-6 FORMAT		2834 1451	9
		2834 1451	10
HISTORY		2834 1451	11
82-08 NEW EVALUATION FOR JENDL-2 WAS MADE BY Y.KIKUCHI (JAERI) AND		2834 1451	12
N.SEKINE (HEC).		2834 1451	13
83-11 COMMENT WAS ADDED.		2834 1451	14
90-01 PHOTON PRODUCTION ADDED (ECN). DATA FROM THE 60-NI JEF-2		2834 1451	15
EVALUATION USED AS AN ESTIMATE (SEE REF. /10/).		2834 1451	16
		2834 1451	17
MF=1,MT=451 COMMENTS AND DICTIONARY		2834 1451	18
		2834 1451	19
MF=2,MT=151		2834 1451	20
MISE A JOUR MARS 85 INCORPORATION PEREY 1982 WISSHAK 1983		2834 1451	21
SECTION EFFICACES TOTALES, ELASTIQUES ET DE CAPTURE DANS LE		2834 1451	22
DOMAINE THERMIQUE ET DANS LE DOMAINE DES RESONNANCES.		2834 1451	23
TOUS LES RENSEIGNEMENTS CONCERNANT CETTE EVALUATION SE TROUVENT		2834 1451	24
DANS LA NOTE TECHNIQUE: (DRNR/SPCI/LEPH/85.215 MARS 85)		2834 1451	25
		2834 1451	26
MF=3 NEUTRON CROSS SECTIONS		2834 1451	27
BACKGROUND CROSS SECTIONS (BGCS) APPLIED TO RESONANCE REGION.		2834 1451	28
MT=1,2 : MANY POINT BGCS TO COMPENSATE ERRORS DUE TO CONSTANT		2834 1451	29
R AND RESONANCE TRUNCATION /4/.		2834 1451	30
MT=102 : SMOOTH BGCS ABOVE 40 KEV.		2834 1451	31
		2834 1451	32
CROSS SECTIONS ABOVE 68.5 KEV EVALUATED AS FOLLOWS :		2834 1451	33
		2834 1451	34
MT=1 : TOTAL CROSS SECTION		2834 1451	35
CALCULATED WITH OPTICAL MODEL.		2834 1451	36
POTENTIAL PARAMETERS OBTAINED BY FITTING NAT-NI DATA /5/:		2834 1451	37
V =51.33 - 0.331*EN ,WS=8.068 + 0.112*EN ,VSO=7.0 (MEV)		2834 1451	38
R0=RSO=1.24 ,RS=1.40 (FM)		2834 1451	39
A0=ASO=0.541 ,B =0.4 (FM)		2834 1451	40
		2834 1451	41
MT=2 : ELASTIC SCATTERING		2834 1451	42
(TOTAL) - (ALL THE OTHER PARTIAL CROSS SECTIONS).		2834 1451	43
		2834 1451	44
MT=16,28 : (N,2N) AND (N,NP)		2834 1451	45
CALCULATED WITH EVAPORATION MODEL.		2834 1451	46
		2834 1451	47
MT=51-70,91,102 : INELASTIC SCATTERING AND CAPTURE		2834 1451	48
CALCULATED WITH THE STATISTICAL MODEL CODE CASTHY /6/.		2834 1451	49
COMPETING PROCESSES : (N,2N) , (N,P) , (N,A) , (N,NP) .		2834 1451	50
LEVEL FLUCTUATION CONSIDERED.		2834 1451	51
THE LEVEL SCHEME TAKEN FROM REF./7/.		2834 1451	52
		2834 1451	53
NO ENERGY (MEV) SPIN-PARITY		2834 1451	54
G.S. 0 3/2 -		2834 1451	55
1 0.0674 5/2 -		2834 1451	56
2 0.2380 1/2 -		2834 1451	57
3 0.6560 3/2 -		2834 1451	58
4 0.9088 5/2 -		2834 1451	59
5 1.0150 7/2 -		2834 1451	60
6 1.1000 3/2 -		2834 1451	61
7 1.1323 5/2 -		2834 1451	62
8 1.1857 3/2 -		2834 1451	63
9 1.4580 7/2 -		2834 1451	64
10 1.6100 5/2 -		2834 1451	64

11	1.7298	3/2 -	2834	1451	65
12	1.8080	7/2 -	2834	1451	66
13	1.9780	9/2 -	2834	1451	67
14	1.9970	3/2 +	2834	1451	68
15	2.0030	7/2 -	2834	1451	69
16	2.0190	7/2 -	2834	1451	70
17	2.1140	9/2 +	2834	1451	71
18	2.1230	1/2 -	2834	1451	72
19	2.4100	5/2 -	2834	1451	73
20	2.4660	7/2 -	2834	1451	74
CONTINUUM LEVELS ASSUMED ABOVE 2.528 MEV.			2834	1451	75
THE LEVEL DENSITY PARAMETERS EVALUATED BY YOSHIDA /8/			2834	1451	76
NI-ISOTOPE 60 61 62			2834	1451	77
A (1/MEV)	7.55	8.14 8.77	2834	1451	78
DELTA (MEV)	2.47	1.20 2.60	2834	1451	79
EX (MEV)	10.00	7.00 9.00	2834	1451	80
TC (MEV)	1.26	1.17 1.08	2834	1451	81
THE GAMMA-RAY STRENGTH FUNCTION OF 4.65E-4 OBTAINED FROM			2834	1451	82
THE CAPTURE CROSS SECTION DATA OF ERNST+ /10/			2834	1451	83
MT=103 : (N,P)			2834	1451	84
EVALUATED ON THE ANALOGY OF NI-60 (N,P) CROSS SECTION.			2834	1451	85
MT=107 : (N,A)			2834	1451	86
EVALUATED ON THE ANALOGY OF CO-59 (N,A) CROSS SECTION.			2834	1451	87
MT=251 : MU-BAR			2834	1451	88
CALCULATED WITH OPTICAL MODEL.			2834	1451	89
MF=4 ANGULAR DISTRIBUTIONS OF SECONDARY NEUTRONS			2834	1451	90
MT=2 : CALCULATED WITH OPTICAL MODEL.			2834	1451	91
MT=16,28 : ISOTROPIC IN THE LABORATORY SYSTEM.			2834	1451	92
MT=51-70 : 90 DEGREE SYMMETRIC IN THE CENTER-OF-MASS SYSTEM,			2834	1451	93
CALCULATED WITH CASTHY.			2834	1451	94
MT=91 : 90 DEGREE SYMMETRIC IN THE LABORATORY SYSTEM,			2834	1451	95
CALCULATED WITH CASTHY.			2834	1451	96
MF=5 ENERGY DISTRIBUTIONS OF SECONDARY NEUTRONS			2834	1451	97
MT=16,28,91 : EVAPORATION SPECTRUM.			2834	1451	98
MF=12 PHOTON MULTIPLICITIES			2834	1451	99
MT=3 LUMPED PHOTON PRODUCTION ABOVE 1 MEV (MAURINA CODE)			2834	1451	100
MT=102 (N,G) REACTION BELOW 1 MEV (GNASH CODE)			2834	1451	101
MF=14 ANGULAR DISTRIBUTIONS			2834	1451	102
MT=3, 102 ASSUMED ISOTROPIC IN CM SYSTEM			2834	1451	103
MF=15 ENERGY DISTRIBUTION			2834	1451	104
MT=3 NORMALIZED ENERGY DISTRIBUTIONS (EN > 1 MEV).			2834	1451	105
MT=102 NORMALIZED ENERGY DISTRIBUTIONS (EN < 1 MEV).			2834	1451	106
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3) HOCKENBURY R.W. ET AL.: PHYS.REV.,178,1746 (1969).			2834	1451	112
4) KIKUCHI Y. AND SEKINE N. : TO BE PUBLISHED AS JAERI-M REPORT.			2834	1451	113
5) KAWAI M. : UNPUBLISHED.			2834	1451	114
6) IGARASI S.: J.NUCL.SCI.TECHNOL.,12,67 (1975).			2834	1451	115

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	2834 1451	128
	2834 1451	129
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	2834 1451	131
	2834 1451	132
	2834 1451	133
	2834 1451	134

28-NI- 62 JEF-2	RCOM-NOV87 GRUPPELAAR, VD.KAMP, KOPECKY, NIEROP	2837 1451	5
	DIST-DEC88	2837 1451	6
----JEF-2	MATERIAL 2837	2837 1451	7
-----INCIDENT NEUTRON DATA		2837 1451	8
-----ENDF-6 FORMAT		2837 1451	9
HISTORY		2837 1451	10
82-08 NEW EVALUATION FOR JENDL-2 WAS MADE BY Y.KIKUCHI (JAERI) AND		2837 1451	11
N.SEKINE (HEC).		2837 1451	12
83-11 COMMENT WAS ADDED.		2837 1451	13
87-04 HERVE'S RESONANCE PARAMETERS INSERTED		2837 1451	14
90-01 PHOTON PRODUCTION ADDED (ECN). DATA FROM THE 60-NI JEF-2		2837 1451	15
EVALUATION USED AS AN ESTIMATE (SEE REF. /9/).		2837 1451	16
		2837 1451	17
MF=1,MT=451 COMMENTS AND DICTIONARY		2837 1451	18
		2837 1451	19
MF=2,MT=151		2837 1451	20
MISE A JOUR MARS 85 INCORPORATION PEREY 1982 WISSHAK 1983		2837 1451	21
SECTION EFFICACES TOTALES, ELASTIQUES ET DE CAPTURE DANS LE		2837 1451	22
DOMAINE THERMIQUE ET DANS LE DOMAINE DES RESONNANCES.		2837 1451	23
TOUS LES RENSEIGNEMENTS CONCERNANT CETTE EVALUATION SE TROUVENT		2837 1451	24
DANS LA NOTE TECHNIQUE: (DRNR/SPCI/LEPH/85.215 MARS 85)		2837 1451	25
		2837 1451	26
MF=3 NEUTRON CROSS SECTIONS		2837 1451	27
BACKGROUND CROSS SECTIONS (BGCS) APPLIED TO RESONANCE REGION.		2837 1451	28
MT=1,2 : MANY POINT BGCS TO COMPENSATE ERRORS DUE TO CONSTANT		2837 1451	29
R AND RESONANCE TRUNCATION /3/.		2837 1451	30
MT=102 : SMOOTH BGCS ABOVE 150 KEV.		2837 1451	31
		2837 1451	32
CROSS SECTIONS ABOVE 600 KEV EVALUATED AS FOLLOWS :		2837 1451	33
		2837 1451	34
MT=1 : TOTAL CROSS SECTION		2837 1451	35
CALCULATED WITH OPTICAL MODEL.		2837 1451	36
POTENTIAL PARAMETERS OBTAINED BY FITTING NAT-NI DATA /4/:		2837 1451	37
V =51.33 - 0.331*EN ,WS=8.068 + 0.112*EN ,VSO=7.0 (MEV)		2837 1451	38
R0=RSO=1.24 ,RS=1.40 (FM)		2837 1451	39
A0=ASO=0.541 ,B =0.4 (FM)		2837 1451	40
		2837 1451	41
MT=2 : ELASTIC SCATTERING		2837 1451	42
(TOTAL) - (ALL THE OTHER PARTIAL CROSS SECTIONS).		2837 1451	43
		2837 1451	44
MT=16,28 : (N,2N) AND (N,NP)		2837 1451	45
CALCULATED WITH EVAPORATION MODEL.		2837 1451	46
		2837 1451	47
MT=51 : INELASTIC SCATTERING TO THE 1ST LEVEL		2837 1451	48
EVALUATED ON THE BASIS OF EXPERIMENTAL DATA UP TO 7 MEV.		2837 1451	49
DIRECT REACTION CALCULATED WITH DWBA AND ADDED ABOVE 7 MEV		2837 1451	50
		2837 1451	51
MT=52-71,91,102 : INELASTIC SCATTERING AND CAPTURE		2837 1451	52
CALCULATED WITH THE STATISTICAL MODEL CODE CASTHY /5/.		2837 1451	53
COMPETING PROCESSES : (N,2N) , (N,P) , (N,A) , (N,NP) .		2837 1451	54
LEVEL FLUCTUATION CONSIDERED.		2837 1451	55
THE LEVEL SCHEME TAKEN FROM REF./6/.		2837 1451	56
NO ENERGY (MEV) SPIN-PARITY		2837 1451	57
G.S. 0 0 +		2837 1451	58
1 1.1729 2 +		2837 1451	59
2 2.0486 0 +		2837 1451	60
3 2.3018 2 +		2837 1451	61
4 2.3364 4 +		2837 1451	62
5 2.8912 0 +		2837 1451	63
6 3.0582 2 +		2837 1451	64

7	3.1580	2 +	2837 1451	65
8	3.1765	4 +	2837 1451	66
9	3.2577	2 +	2837 1451	67
10	3.2620	4 +	2837 1451	68
11	3.2699	2 +	2837 1451	69
12	3.2774	4 +	2837 1451	70
13	3.3703	1 +	2837 1451	71
14	3.4620	4 +	2837 1451	72
15	3.4860	0 +	2837 1451	73
16	3.5185	2 +	2837 1451	74
17	3.5229	3 +	2837 1451	75
18	3.7570	3 -	2837 1451	76
19	3.8493	1 +	2837 1451	77
20	3.8530	2 +	2837 1451	78
21	3.8600	2 +	2837 1451	79
CONTINUUM LEVELS ASSUMED ABOVE 3.967 MEV.			2837 1451	80
THE LEVEL DENSITY PARAMETERS EVALUATED BY YOSHIDA /7/.			2837 1451	81
NI-ISOTOPE	61	62	63	2837 1451 82
A (1/MEV)	8.14	8.77	9.37	2837 1451 83
DELTA (MEV)	1.20	2.60	1.20	2837 1451 84
EX (MEV)	7.00	9.00	3.00	2837 1451 85
TC (MEV)	1.17	1.08	1.36	2837 1451 86
THE GAMMA-RAY STRENGTH FUNCTION OF 1.38E-5 OBTAINED FROM			2837 1451	87
THE CAPTURE CROSS SECTION DATA OF BEER+/1/.			2837 1451	88
MT=103 : (N,P)			2837 1451	89
EVALUATED ON THE ANALOGY OF NI-60 (N,P) CROSS SECTION.			2837 1451	90
MT=107 : (N,A)			2837 1451	91
EVALUATED ON THE ANALOGY OF CO-59 (N,A) CROSS SECTION.			2837 1451	92
MT=251 : MU-BAR			2837 1451	93
CALCULATED WITH OPTICAL MODEL.			2837 1451	94
MF=4 ANGULAR DISTRIBUTIONS OF SECONDARY NEUTRONS			2837 1451	95
MT=2 : CALCULATED WITH OPTICAL MODEL.			2837 1451	96
MT=16,28 : ISOTROPIC IN THE LABORATORY SYSTEM.			2837 1451	97
MT=51-71 : 90 DEGREE SYMMETRIC IN THE CENTER-OF-MASS SYSTEM,			2837 1451	98
CALCULATED WITH CASTHY.			2837 1451	99
MT=91 : 90 DEGREE SYMMETRIC IN THE LABORATORY SYSTEM,			2837 1451	100
CALCULATED WITH CASTHY.			2837 1451	101
MF=5 ENERGY DISTRIBUTIONS OF SECONDARY NEUTRONS			2837 1451	102
MT=16,28,91 : EVAPORATION SPECTRUM.			2837 1451	103
MF=12 PHOTON MULTIPLICITIES			2837 1451	104
MT=3 LUMPED PHOTON PRODUCTION ABOVE 1 MEV (MAURINA CODE)			2837 1451	105
MT=102 (N,G) REACTION BELOW 1 MEV (GNASH CODE)			2837 1451	106
MF=14 ANGULAR DISTRIBUTIONS			2837 1451	107
MT=3, 102 ASSUMED ISOTROPIC IN CM SYSTEM			2837 1451	108
MF=15 ENERGY DISTRIBUTION			2837 1451	109
MT=3 NORMALIZED ENERGY DISTRIBUTIONS (EN > 1 MEV).			2837 1451	110
MT=102 NORMALIZED ENERGY DISTRIBUTIONS (EN < 1 MEV).			2837 1451	111
REFERENCES			2837 1451	112
1) BEER H. AND SPENCER R.R.: NUCL.PHYS.,A240,29 (1975).			2837 1451	113
2) FARRELL J.A. ET AL.: ANN.PHYS.,37,367 (1966).			2837 1451	114
			2837 1451	115
			2837 1451	116
			2837 1451	117
			2837 1451	118
			2837 1451	119
			2837 1451	120
			2837 1451	121
			2837 1451	122
			2837 1451	123
			2837 1451	124

3) KIKUCHI Y. AND SEKINE N. : TO BE PUBLISHED AS JAERI-M REPORT.	2837	1451	125
4) KAWAI M. : UNPUBLISHED.	2837	1451	126
5) IGARASI S.: J.NUCL.SCI.TECHNOL.,12,67 (1975).	2837	1451	127
6) LEDERER C.M. AND SHIRLEY V.S.: TABLE OF ISOTOPES,7TH EDITION, WILEY-INTERSCIENCE (1978).	2837	1451	128
7) YOSHIDA T. : UNPUBLISHED.	2837	1451	129
9) H. GRUPPELAAR, H. V.D. KAMP, J. KOPECKY, D. NIEROP AND M. UHL,"EVALUATION OF NEUTRON CROSS-SECTIONS AND PHOTON-PRODUCTION DATA FOR NI-ISOTOPES IN THE ENERGY RANGE 0 - 20 MEV", JEF-DOC (1990), ECN-REPORT, ECN-90.	2837	1451	130
	2837	1451	131
	2837	1451	132
	2837	1451	133
	2837	1451	134

28-NI- 64 JEF-2	RCOM-NOV87 GRUPPELAAR, VD. KAMP, KOPECKY, NIEROP	2843 1451	5
	DIST-DEC88	2843 1451	6
----JEF-2	MATERIAL 2843	2843 1451	7
-----INCIDENT NEUTRON DATA		2843 1451	8
-----ENDF-6 FORMAT		2843 1451	9
HISTORY		2843 1451	10
82-08 NEW EVALUATION FOR JENDL-2 WAS MADE BY Y.KIKUCHI (JAERI) AND		2843 1451	11
N. SEKINE (HEC).		2843 1451	12
83-11 COMMENT WAS ADDED.		2843 1451	13
88-04 HERVE'S RESONANCE PARAMETERS INTERESTED		2843 1451	14
90-01 PHOTON PRODUCTION ADDED (ECN). DATA FROM THE 60-NI JEF-2		2843 1451	15
EVALUATION USED AS AN ESTIMATE (SEE REF. /8/).		2843 1451	16
		2843 1451	17
MF=1, MT=451 COMMENTS AND DICTIONARY		2843 1451	18
		2843 1451	19
MF=2, MT=151		2843 1451	20
MISE A JOUR MARS 85 INCORPORATION PEREY 1982 WISSHAK 1983		2843 1451	21
SECTION EFFICACES TOTALES, ELASTIQUES ET DE CAPTURE DANS LE		2843 1451	22
DOMAINE THERMIQUE ET DANS LE DOMAINE DES RESONNANCES.		2843 1451	23
TOUS LES RENSEIGNEMENTS CONCERNANT CETTE EVALUATION SE TROUVENT		2843 1451	24
DANS LA NOTE TECHNIQUE: (DRNR/SPCI/LEPH/85.215 MARS 85)		2843 1451	25
		2843 1451	26
MF=3 NEUTRON CROSS SECTIONS		2843 1451	27
BACKGROUND CROSS SECTIONS (BGCS) APPLIED TO RESONANCE REGION.		2843 1451	28
MT=1,2 : MANY POINT BGCS TO COMPENSATE ERRORS DUE TO CONSTANT		2843 1451	29
R AND RESONANCE TRUNCATION /3/.		2843 1451	30
MT=102 : SMOOTH BGCS ABOVE 370 KEV.		2843 1451	31
		2843 1451	32
CROSS SECTIONS ABOVE 600 KEV EVALUATED AS FOLLOWS :		2843 1451	33
		2843 1451	34
MT=1 : TOTAL CROSS SECTION		2843 1451	35
CALCULATED WITH OPTICAL MODEL.		2843 1451	36
POTENTIAL PARAMETERS OBTAINED BY FITTING NAT-NI DATA /4/:		2843 1451	37
V =51.33 - 0.331*EN , WS=8.068 + 0.112*EN , VSO=7.0 (MEV)		2843 1451	38
R0=RSO=1.24 , RS=1.40 (FM)		2843 1451	39
A0=ASO=0.541 , B =0.4 (FM)		2843 1451	40
		2843 1451	41
MT=2 : ELASTIC SCATTERING		2843 1451	42
(TOTAL) - (ALL THE OTHER PARTIAL CROSS SECTIONS).		2843 1451	43
		2843 1451	44
MT=16,17 : (N,2N) AND (N,3N)		2843 1451	45
CALCULATED WITH EVAPORATION MODEL.		2843 1451	46
		2843 1451	47
MT=51 : INELASTIC SCATTERING TO THE 1ST LEVEL		2843 1451	48
DIRECT REACTION CALCULATED WITH DWBA, ADDED ABOVE 7 MEV		2843 1451	49
		2843 1451	50
MT=52-70,91,102 : INELASTIC SCATTERING AND CAPTURE		2843 1451	51
CALCULATED WITH THE STATISTICAL MODEL CODE CASTHY /5/.		2843 1451	52
COMPETING PROCESSES : (N,2N) , (N,3N) , (N,P) , (N,A) .		2843 1451	53
LEVEL FLUCTUATION CONSIDERED.		2843 1451	54
THE LEVEL SCHEME TAKEN FROM REF./6/.		2843 1451	55
NO ENERGY (MEV) SPIN-PARITY		2843 1451	56
G.S. 0 0 +		2843 1451	57
1 1.3459 2 +		2843 1451	58
2 2.2750 0 +		2843 1451	59
3 2.6080 4 +		2843 1451	60
4 2.7500 2 +		2843 1451	61
5 2.8650 0 +		2843 1451	62
6 2.8850 2 +		2843 1451	63
7 2.9710 2 +		2843 1451	64

8	3.0280	0 +	2843	1451	65
9	3.1650	4 +	2843	1451	66
10	3.2730	2 +	2843	1451	67
11	3.393	3 +	2843	1451	68
12	3.459	1 +	2843	1451	69
13	3.483	4 +	2843	1451	70
14	3.560	3 -	2843	1451	71
15	3.647	2 +	2843	1451	72
16	3.748	4 +	2843	1451	73
17	3.795	1 +	2843	1451	74
18	3.808	3 +	2843	1451	75
19	3.848	5 -	2843	1451	76
20	3.965	4 +	2843	1451	77
CONTINUUM LEVELS ASSUMED ABOVE 4.084 MEV.			2843	1451	78
THE LEVEL DENSITY PARAMETERS EVALUATED BY YOSHIDA /7/.			2843	1451	79
NI-ISOTOPE	62	63	64	65	2843 1451 80
A (1/MEV)	8.77	9.37	9.98	10.57	2843 1451 81
DELTA (MEV)	2.60	1.20	2.70	1.20	2843 1451 82
EX (MEV)	9.00	3.00	4.32	4.00	2843 1451 83
TC (MEV)	1.08	1.36	1.15	0.947	2843 1451 84
THE GAMMA-RAY STRENGTH FUNCTION OF 7.67E-6 OBTAINED FROM			2843	1451	85
THE CAPTURE CROSS SECTION DATA OF BEER+/1/.			2843	1451	86
MT=103 : (N,P)			2843	1451	87
EVALUATED ON THE ANALOGY OF NI-60 (N,P) CROSS SECTION.			2843	1451	88
MT=107 : (N,A)			2843	1451	89
EVALUATED ON THE ANALOGY OF CO-59 (N,A) CROSS SECTION.			2843	1451	90
MT=251 : MU-BAR			2843	1451	91
CALCULATED WITH OPTICAL MODEL.			2843	1451	92
MF=4 ANGULAR DISTRIBUTIONS OF SECONDARY NEUTRONS			2843	1451	93
MT=2 : CALCULATED WITH OPTICAL MODEL.			2843	1451	94
MT=16,17 : ISOTROPIC IN THE LABORATORY SYSTEM.			2843	1451	95
MT=51-70 : 90 DEGREE SYMMETRIC IN THE CENTER-OF-MASS SYSTEM,			2843	1451	96
CALCULATED WITH CASTHY.			2843	1451	97
MT=91 : 90 DEGREE SYMMETRIC IN THE LABORATORY SYSTEM,			2843	1451	98
CALCULATED WITH CASTHY.			2843	1451	99
MF=5 ENERGY DISTRIBUTIONS OF SECONDARY NEUTRONS			2843	1451	100
MT=16,17,91 : EVAPORATION SPECTRUM.			2843	1451	101
MF=12 PHOTON MULTIPLICITIES			2843	1451	102
MT=3 LUMPED PHOTON PRODUCTION ABOVE 1 MEV (MAURINA CODE)			2843	1451	103
MT=102 (N,G) REACTION BELOW 1 MEV (GNASH CODE)			2843	1451	104
MF=14 ANGULAR DISTRIBUTIONS			2843	1451	105
MT=3, 102 ASSUMED ISOTROPIC IN CM SYSTEM			2843	1451	106
MF=15 ENERGY DISTRIBUTION			2843	1451	107
MT=3 NORMALIZED ENERGY DISTRIBUTIONS (EN > 1 MEV).			2843	1451	108
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	2843 1451	132