

Engine Poppet Valve Materials — SAE J775 JUL80

SAE Information Report
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ENGINE POPPET VALVE MATERIALS—SAE J775 JUL80

SAE Information Report

Report of the Iron and Steel Technical Committee, approved June 1961, completely revised July 1980.

Introduction—Poppet valve materials are: iron-, titanium-, nickel-, and cobalt-base metallic alloys possessing the capability to control gas flow in internal combustion engines. For exhaust valves, specially designed high-temperature austenitic and martensitic alloys are used. Intake valves are low- to highly-alloyed martensitic and austenitic materials or, in some instances, titanium alloys. The conditions of operation are controlled primarily by the gases during the combustion process or their flow past the valve during gas intake or exhaust portion of the cycle. These conditions include high temperatures and oxidizing or corroding atmospheres. Stresses result from firing, spring seating, and acceleration and deceleration forces.

Purpose and Scope—This report supplies engineers and designers with the following general information:

1. Valve assembly nomenclature, Fig. 1
2. The nominal analyses of valve materials, Table 1
3. General information on typical physical and mechanical properties of valve materials, Tables 2, 3, and 4
4. A classification of valve materials according to type, severity, and durability requirements of the end use
5. Description of valve design and construction and its relation to valve material
6. Typical heat treatments, Table 5

Designation of SAE Valve Steels—The majority of valve material applications can be divided into functional groups which make possible an orderly system of identification. The SAE numbers used throughout this report are related to the type of valve in which the material is commonly used. Numbers have been assigned on the following bases:

1. Letter Prefix—Intake valves may be made of structural low-alloy steels, or heat and corrosion resistant high-alloy steels. The prefix *NV* designates low-alloy structural steels and *HNV* designates high-alloy steels.

Exhaust valves may be made of hardenable martensitic steels, austenitic steels, or superalloys. Materials used for exhaust valves may be iron-, nickel-, or cobalt-base alloys. The prefix letters *EV* are used to designate austenitic exhaust valve steels, and the letters *HEV* for the high strength alloys used in severe diesel and gasoline engine service.

High-alloy, welded overlays used at critical points of wear or corrosion have been designated in the material tables with the prefix *VF*.

2. Number Suffix—A number is arbitrarily assigned, based on the order in which the material appears in the various categories of Table 1. Future grades will be assigned numbers in the order in which they are added to a category.

3. SAE Number—Where an SAE alloy or stainless steel number presently exists for a valve steel, the SAE number appears in parentheses following the valve steel number.

Mechanical and Physical Properties—The selection of valve materials is based on a number of mechanical and physical characteristics of the steels and/or alloys. No single test is effective in defining varying conditions encountered in different internal combustion engines. The mechanical property data function as a guideline in material selection. Final approval is usually made on the basis of engine test results. Of the failure modes, corrosion fatigue or fatigue in the absence of corrosion (underhead stem failures) are most common. Corrosion resistance (resistance to burning failures) is next in order of occurrence. Thermal fatigue failure by radial cracking of the heads of exhaust valves is a third failure mode.

In the absence of a standard corrosion test, no data are cited specifically for laboratory corrosion test results. Crucible immersion tests with lead oxide as a corrodent are often used. Specimens buried in a pile or cone of lead oxide and engine tests with a bored hole through the head of the valve are also used. Valve manufacturers or steel sources can generally supply data. In addition, air oxidation tests are run at high temperatures to shorten testing time. Sulfidation tests are performed using gas atmospheres or immersion-type tests.

The corrosion of valves is accelerated as a result of both their temperature and environment. Corrosion occurs through three mechanisms:

1. Oxidation
2. Attack by various metal oxides and salts
3. Attack by fuel and lubricant additives or contaminants

Valve alloys are high in chromium and sometimes contain silicon to give

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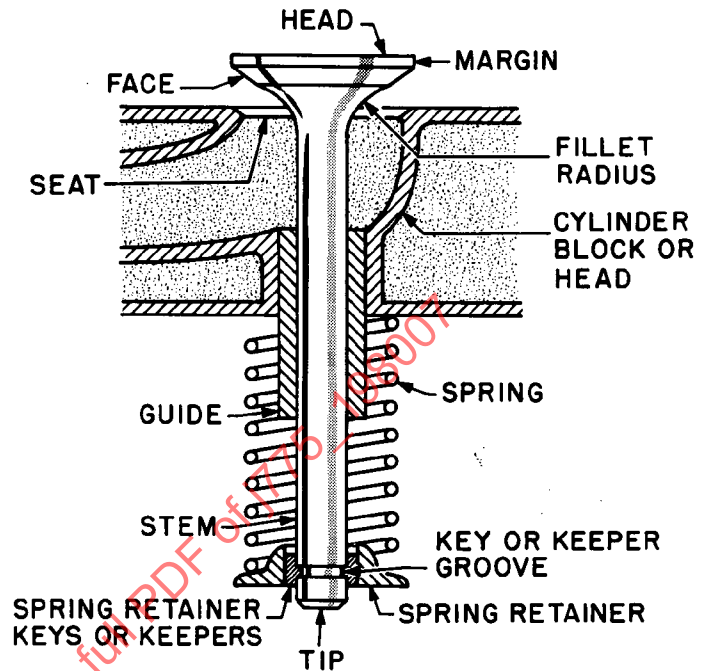


FIG. 1—VALVE ASSEMBLY NOMENCLATURE

them inherent oxidation resistance. Silicon is sometimes intentionally removed from exhaust valve alloys to prevent certain surface reactions with metal oxides. Diesel engine valve alloys frequently have high chromium contents to afford protection from sulfur attack, particularly in alloys which contain substantial nickel contents.

Fatigue data and/or corrosion fatigue data are limited. The situation is improving, and more data are being gathered on a systematic basis by both valve and steel manufacturers. In lieu of these data, estimates of fatigue resistance are usually established on the basis of elevated-temperature tensile, creep, or stress rupture tests and hot hardness data. Tables 2 and 3 show the data.

Heat Treatment—Heat treatments used to develop valve mechanical properties are varied based on economics and the level of properties desired. Intake valves are normally hardened and tempered or used in the annealed condition. Passenger car exhaust valves are usually used in the forged and aged condition. More severe exhaust valve applications are generally met with a solution treatment followed by one or more aging treatments. Typical heat treatments are shown in Table 5.

Classification of Valve Steels—Valve steels are classified according to the service use. Intake valve steels generally are carbon, or low-alloy steels. Exhaust valve steels are usually austenitic.

Some high-alloy martensitic steels are used in heavy-duty gasoline and diesel engines as intake valve steels. Similarly, these same martensitic steels are used as exhaust valve steels for light-duty cycle operation.

Martensitic Steels—The martensitic alloys normally are characterized by 0.40% carbon content. Extreme-duty types may have a higher carbon content to resist wear, face indentation by deposits, and/or to increase strength. Other elements such as chromium or silicon will be added where increased oxidation or corrosion resistance is needed. Manganese and nickel will be added as strengthening elements with low refractory element content to enhance some elevated temperature properties.

Hardness levels vary, but many parts are made within the range of 30–40 R_C . This represents a compromise between good strength, ductility, and impact properties versus wear resistance in the stem. Tips are hardened to 45–60 R_C to resist wear. Tip hardening can extend through the lock groove area to improve its fatigue strength.

TABLE 1—NUMBERING SYSTEM, CHEMICAL COMPOSITION, NOMINAL ANALYSES OF TYPICAL VALVE ALLOYS, %

UNS No.	SAE No.	C	Mn	Si	Cr	Ni	Co	W	Mo	Fe	Other	Similar Commercial Designation
Current Intake Valve or Stem Stock Alloys												
G15410	NV 1 (SAE 1541)	0.41	1.50	0.25	—	—	—	—	—	Base	—	—
G15470	NV 2 (SAE 1547)	0.47	1.50	0.25	—	—	—	—	—	Base	—	—
G31410	NV 3	0.50	0.80	0.30	0.40	0.30	—	—	0.15	Base	—	NE 8150
G86450	NV 4 (SAE 3140)	0.40	0.80	0.30	0.65	1.25	—	—	—	Base	—	—
	NV 5	0.45	0.90	0.30	0.50	0.55	—	—	0.20	Base	—	—
G51500	NV 6 (SAE 5150)	0.50	0.80	0.30	0.80	—	—	—	—	Base	—	—
G41400	NV 7 (SAE 4140)	0.40	0.87	0.27	0.95	—	—	—	0.20	Base	—	—
	NV 8	0.40	0.30	3.8	2.15	0.25	—	—	0.10	Base	Cu 0.25	GM-8440
	NV 9	0.39	0.75	0.25	—	—	—	—	—	Base	—	—
K65007	HN 3	0.45	0.40	3.3	8.5	—	—	—	—	Base	—	Sil 1
K65006	HN 6	0.80	0.40	2.3	20.0	1.30	—	—	—	Base	—	Sil XB
	HN 7 (SAE 71360)	0.55	0.20	0.20	3.5	—	—	14.0	—	Base	—	—
S42200	HN 8	0.23	0.75	0.35	12.0	0.80	—	1.0	1.0	Base	V 0.25	422 SS
Current Exhaust Valve Alloys												
Austenitic												
K63017	EV 4	0.20	1.3	1.0	21.0	11.5	—	—	—	Base	N 0.18	21-12N
K63014	EV 5	0.38	1.0	3.0	19.0	8.0	—	—	—	Base	—	Sil 10
	EV 6	0.38	1.0	3.0	19.0	8.0	—	—	—	Base	N 0.2	Sil 10N
K63008	EV 8	0.53	9.0	0.15	21.0	3.75	—	—	—	Base	N 0.42	21-4N
K63009	EV 9	0.45	0.5	0.60	14.0	14.0	—	2.40	0.35	Base	—	TPA
K63011	EV 11	0.70	6.3	0.55	21.0	1.9	—	—	—	Base	N 0.23	Sil 746
K63012	EV 12	0.65	8.3	0.15	21.0	2.2	—	—	—	Base	N 0.30	21-2N
	EV 13	0.53	11.5	2.60	21.0	—	—	—	—	Base	N 0.40	Gaman H
	EV 14	0.20	6.5	0.40	21.0	5.5	—	—	—	Base	N 0.20	21-5-7
	EV 15	0.32	2.0	0.7	23.0	7.5	—	—	—	Base	N 0.52	Nitronic 20 ^a
	EV 16	0.33	3.0	0.7	23.0	8.0	—	—	—	Base	N 0.38	EMS 235
	EV 17	0.10	2.0	1.0	18.0	9.0	—	—	—	Base	Cu 3.50	302
Superalloys												
K64006	HEV 2	0.04	2.25	0.08	16.0	Base	0.50	—	—	6.5	Cu 0.1	Inconel 721 ^b
	HEV 3	0.05	0.60	0.30	15.0	Base	—	—	—	7.0	Ti 3.05	Inconel X751 ^b
											Al 1.20	
											Ti 2.40	
											Ta 1.0	
N07080	HEV 5	0.05	1.0	0.60	20.0	Base	2.0	—	—	3.0	Al 1.4	Nimonic 80 ^c
											Ti 2.25	
											B 0.003	
N07090	HEV 6	0.05	1.0	1.50	20.0	Base	18.0	—	—	—	Al 1.40	Nimonic 90 ^c
											Ti 2.40	
K66286	HEV 7	0.08	1.50	0.70	14.75	26.0	—	—	1.25	Base	B 0.003	A-286
											Ti 2.0	
											V 0.30	
											Al 0.35	
	HEV 8	0.04	0.20	0.20	22.70	Base	—	—	2.0	13.0	B 0.003	Pyromet 31 ^d
											Ti 2.30	
											Al 1.30	
											B 0.005	
											Nb 0.85	
Current Facing Alloys												
Alloy Overlays												
R30006	VF 1	0.20	0.80	0.20	20.0	Base	—	—	—	1.0	—	80-20-Ni-Cr
	VF 2	1.20	0.50	1.20	28.0	3.0	Base	4.50	0.50	3.0	—	HAYNES ^e
N06005	VF 3	2.40	—	0.70	29.0	Base	10.0	15.0	—	6.5	—	STELLITE 6
N06782	VF 4	2.00	0.30	0.30	26.0	Base	0.5	8.75	—	4.0	—	Eatonite
R30002	VF 5	1.75	0.30	1.00	25.0	22.0	Base	12.0	—	2.0	—	X-782
												HAYNES ^e
R30001	VF 6	2.50	0.50	1.30	30.0	1.50	Base	13.0	0.50	3.0	—	STELLITE F
												HAYNES ^e
R30012	VF 7	1.40	2.50	0.70	30.0	1.50	Base	8.30	—	3.0	—	STELLITE 1
												HAYNES ^e
	VF 8	0.60	—	2.40	8.0	—	61.0	—	28.0	—	Fe 3.0	STELLITE 12
												TRIBALLOY T-400
	VF 9	1.8	—	1.5	29.0	Base	—	—	5.5	8.0	—	Eatonite 3
	VF 10	2.2	—	1.5	29.0	Base	—	—	8.5	8.0	—	Eatonite 5
	VF 11	2.25	—	1.0	24.0	11.0	—	—	5.5	Base	—	VMS-585
Noncurrent Alloys												
	EV 1	0.45	0.50	0.50	23.50	4.80	—	—	2.80	Base	—	XCR
	EV 2	0.40	4.30	0.80	24.0	3.80	—	—	1.40	Base	—	TXCR
	EV 3	0.20	1.30	1.0	21.0	11.50	—	—	—	Base	—	21-12
	EV 7	0.20	5.0	0.50	21.0	4.50	—	—	—	Base	N 0.30	21-5-5N
	EV 10	1.0	0.80	3.0	14.50	14.50	—	—	—	Base	—	Cast 14-14
	HN 1	0.55	0.40	1.50	8.0	—	—	—	0.75	Base	—	Sil 2
	HN 2	0.40	0.30	3.90	2.20	—	—	—	—	Base	—	Sil F
	HN 4	0.45	0.40	3.30	7.0	1.0	—	—	—	Base	—	731
	HN 5	0.35	0.40	2.50	13.0	8.0	—	—	0.50	Base	—	CNS

TABLE 1—NUMBERING SYSTEM, CHEMICAL COMPOSITION, NOMINAL ANALYSES OF TYPICAL VALVE ALLOYS, %

UNS No.	SAE No.	C	Mn	Si	Cr	Ni	Co	W	Mo	Fe	Other	Similar Commercial Designation
Limited Usage Experimental Alloys												
	XEV-A	0.50	11.50	0.15	20.50	—	—	2.0	—	Base	N 0.45 V 0.40 Nb 1.0	DV2-A ^f
	XEV-B	0.50	11.50	1.0	20.50	—	—	2.0	—	Base	N 0.45 V 0.40 Nb 1.0	DV2-B ^f
	XEV-D	0.55	8.25	0.15	21.0	2.80	—	1.75	—	Base	N 0.45 V 0.35	AV-1 ^f
	XEV-E	0.40	6.50	—	19.0	8.0	—	—	—	Base	Nb 0.10 B 0.0015	CV ^f
	XEV-F	0.60	9.0	0.20	21.0	0.30	—	—	1.0	Base	V 0.75 N 0.45 Nb 1.0	21-4 Nb
	XEV-G	0.10	8.50	—	27.80	0.40	—	—	—	Base	Ti 2.0 Al 1.0	VMS-513
	XEV-H	0.050	0.50	0.750	19.50	Base	13.50	—	4.30	2.0	Ti 3.0 Al 1.30 B 0.005	Waspeloy ^g
	XEV-I	0.040	0.20	0.30	19.0	52.50	—	—	—	18.50	Zr 0.050 Ti 0.90 Al 0.50 B 0.050	Inconel 718 ^b
	XEV-J	—	—	—	—	—	—	—	—	—	Nb 5.30 Ta Ti Base Al 5.85 V 4.0	6 Al 4 V

^aRegistered Trademark, Armco Inc.^bRegistered Trademark, Huntington Alloys, Inc.^cRegistered Trademark, Henry Wiggin & Co., Ltd.^dRegistered Trademark, Carpenter Technology Corp.^eRegistered Trademark, Cabot Corp.^fAlloy Designation, Colt Industries, Crucible Inc.^gRegistered Trademark, United Technologies Corp.

The principal mechanical attribute required is wear resistance coupled with reasonable strength to resist cupping, which can occur where pre-ignition is encountered. The maximum intake valve temperature encountered is less than 650° F (340° C) for passenger cars and 900° F (480° C) for truck engines. Parts are normally supplied in the hardened and tempered condition.

Austenitic Alloys—These steels, by virtue of their alloy content, have a face-centered cubic crystal structure which is termed *austenite*. The elements that stabilize the austenitic structure are carbon, nickel, manganese, and nitrogen. Chromium, silicon, and, sometimes, aluminum are added for oxidation and/or corrosion resistance. Refractory elements (such as tungsten, molybdenum, niobium, and vanadium) may be used for added high-temperature strengthening. Normally these steels are iron-base; however, nickel- and cobalt-base alloys are also used. They may be used either as wrought or cast products, the majority being wrought.

The composition used may be as low and as simple in alloy content as an 18-8 stainless steel, or as complicated as a gas turbine engine material. The selection is strongly influenced by economic considerations as well as the required mechanical attributes that are needed to satisfy specific engine requirements.

Mechanical properties are attained in these materials by precipitation hardening rather than by a martensite transformation. The precipitation treatment usually consists of: (1) aging following a high-temperature forging operation, or (2) high-temperature forging followed by a solution treatment and aging heat treatment(s). These types of operations produce hardness in the 20–40 R_c range. These steels have good fatigue-, creep-, and wear- or face peening-resistance properties at operating temperatures as a result of these heat treatments. Valves for heavy-duty service applications will usually be supplied in the solution and aged condition. Tip hardening is accomplished by butt welding a 0.40–0.50% carbon alloy steel tip and induction hardening it. Many heavy-duty valves have austenitic heads welded to 0.40–0.50% carbon alloy steel stems; the hardened stems extend through the valve guide and include the key groove and tip.

One of the requirements for exhaust valves is resistance to face burning. This is principally achieved through alloy composition as opposed to valve design (that is, valve face angle). Other mechanical properties also of great significance are fatigue strength to resist breakage due primarily to bending loads and creep strength to prevent head cupping. Operating temperatures

are nominally 1300–1400° F (700–760° C) with a maximum of 1500–1550° F (815–840° C). More stringent requirements are met by high-temperature alloys, the peak limit being about 1600–1650° F (870–900° C).

When wear or corrosion conditions or engine-duty service conditions are extreme, the valve face area of standard or high-temperature alloys may be inadequate for such service. In this case, these alloys may be hardfaced to better withstand these types of operating conditions. These can be cobalt-, nickel-, or iron-base materials where the wear resistance is usually due to an extensive precipitation of carbide or other microstructural phases possessing good wear capabilities.

Valve Design and Application as Related to Materials—The design of a valve and its application to the engine are as important as, and frequently much more important than, the selection of the valve material. Valve durability is limited by the operating temperature and stress imposed on it. It is sometimes, but not always, possible to select a stronger or a more temperature-resistant material to overcome limitations in valve design and application.

Good cooling is paramount to satisfactory valve durability, and this implies proper seating of the valve in the engine and proper cooling of the immediate area around the valve seat. There is no known material which will deliver satisfactory durability under conditions of blowby, excessive valve seat distortion, and/or inadequate seat cooling. In general, a reduction in temperature of 25° F (15° C) will approximately double the burning durability of any given material. Again, valve stresses arise generally from the dynamics of the valve train and from the manner in which the valve closes against its seat. Thus careful analysis of the valve train kinematics is a necessity.

In certain instances where valve materials or requisite properties to obtain the desired durability are not available or cannot be used economically, various means of valve fortification are employed. The most important of these are as follows:

1. **Face Coatings**—These are welded overlays applied to valve faces and intended to develop optimum corrosion and wear resistance at the valve seating surface. Cobalt-, nickel-, and iron-base alloys are usually chosen for this purpose.

2. **Head Coatings**—These coatings are applied to the tops of the heads

TABLE 2—TYPICAL MECHANICAL PROPERTIES OF VALVE ALLOYS

UNS No.	SAE No.	Temperature, °F (°C)	Tensile Properties				Brinell Hot Hardness	
			Tensile Strength, ksi (MPa)	Yield Strength, ksi (MPa)	Elongation, %	Reduction of Area, %	Mutual Indentation- BHN	Cold Ball BHN 1400°F (760°C)
Current Intake Valve or Stem Stock Alloys								
G15410	NV 1	Room	141 (970)	132 (910)	—	63	—	—
		1000 (540)	61 (420)	48 (330)	—	75	—	—
G15470	NV 2	Room	180 (1240)	165 (1140)	—	40	—	—
G31410	NV 4	Room	114 (780)	76 (520)	—	—	—	—
		1000 (540)	21 (140)	16.1 (110)	—	—	—	—
		1200 (650)	12.5 (86)	8.3 (57)	—	—	—	—
G86450	NV 5	Room	180 (1240)	165 (1140)	—	40	—	—
G5150	NV 6	Room	143 (990)	132 (910)	—	57	—	—
G41400	NV 7	Room	131 (900)	116 (800)	—	—	—	—
		1000 (540)	72 (500)	56 (390)	—	—	—	—
	NV 8	Room	134 (920)	100 (690)	—	53	—	—
		1000 (540)	39 (270)	32 (220)	—	44	—	—
		1200 (650)	18.2 (130)	16.1 (110)	—	97	—	—
	NV 9	Room	131 (900)	103 (710)	—	68	—	—
K65007	HNV 3	Room	133 (920)	100 (690)	22	50	—	—
		1200 (650)	31 (210)	22 (150)	—	98	63	—
		1400 (760)	10 (69)	9 (62)	—	99	31	—
K65006	HNV 6	Room	136 (940)	122 (840)	15.5	10	—	—
		1200 (650)	29 (200)	23 (160)	—	62	85	—
		1400 (760)	14.5 (100)	10.9 (75)	72	80	40	70
	HNV 7	Room	228 (1570)	193 (1330)	—	18	—	—
		1200 (650)	83 (572)	68 (470)	—	29	—	—
		1400 (760)	—	—	—	—	—	120
S42200	HNV 8	Room	149 (1030)	125 (860)	—	52	—	—
		1200 (650)	52 (360)	46 (310)	—	83	—	—
K63017	EV 4	Room	119 (820)	63 (430)	26.2	20	—	—
		1200 (650)	61 (420)	34 (230)	—	18	100	—
		1400 (760)	43 (300)	31 (220)	13.3	18	80	115
K63014	EV 5	Room	156 (1080)	75 (520)	34.2	26	—	—
		1200 (650)	67 (460)	45 (310)	—	30	145	—
		1400 (760)	41 (280)	35 (240)	—	30	80	120
	EV 6	Room	156 (1080)	75 (520)	34.2	26	—	—
		1200 (650)	67 (460)	45 (310)	—	30	—	—
		1400 (760)	41 (280)	35 (240)	—	30	90	162
K63008	EV 8	Room	166 (1140)	107 (740)	—	9	—	—
		1200 (650)	86 (590)	48 (330)	—	18	185	—
		1400 (760)	62 (430)	37 (260)	18	25	100	193
K63009	EV 9	Room	128 (880)	68 (470)	—	51	—	—
		1200 (650)	76 (520)	34 (230)	—	41	110	—
		1400 (760)	46 (320)	24 (170)	—	50	70	108
K63011	EV 11	Room	150 (1030)	75 (520)	20	15	—	—
		1200 (650)	72 (500)	37 (260)	—	48	165	—
		1400 (760)	50 (340)	30 (210)	8	14	100	—
K63012	EV 12	Room	157 (1080)	102 (700)	—	5	—	—
		1200 (650)	85 (590)	49 (340)	—	27	185	—
		1400 (760)	57 (390)	41 (280)	—	22	100	193
	EV 13	Room	157 (1080)	75 (520)	—	5	—	—
		1200 (650)	78 (940)	51 (350)	—	49	220	—
		1400 (760)	62 (430)	48 (330)	—	22	130	—
	EV 14	Room	128 (880)	70 (480)	—	61	—	—
		1200 (650)	71 (490)	32 (220)	—	60	—	—
		1400 (760)	46 (320)	28 (190)	—	60	—	190
	EV 15	Room	147 (1010)	84 (580)	—	33	—	—
		1200 (650)	84 (580)	39 (270)	—	32	—	—
		1400 (760)	68 (470)	37 (260)	—	30	—	190
	EV 16	Room	73 (500)	27 (190)	—	70	—	—
K64006	HEV 2	Room	150 (1030)	96 (660)	33.5	36	—	—
		1200 (650)	116 (800)	85 (590)	—	—	—	—
		1400 (760)	66 (460)	60 (410)	—	14	210	—
	HEV 3	Room	162 (1120)	92 (630)	—	30	—	—
		1200 (650)	120 (830)	82 (570)	—	21	225	—
		1400 (760)	80 (550)	65 (450)	10	22	195	—
N07080	HEV 5	Room	155 (1070)	90 (620)	39	38	—	—
		1200 (650)	114 (790)	80 (550)	—	17	200	—
		1400 (760)	86 (590)	73 (500)	—	20	150	—
N07090	HEV 6	Room	179 (1230)	110 (760)	—	20	—	—
		1200 (650)	136 (940)	90 (620)	—	12	205	—
		1400 (760)	95 (655)	70 (480)	—	5	185	—
K66286	HEV 7	Room	149 (1030)	102 (700)	—	49	—	—
		1200 (650)	104 (720)	88 (610)	—	14	—	—
		1400 (760)	64 (440)	50 (340)	—	23	—	216
	HEV 8	Room	189 (1300)	112 (770)	—	45	—	—
		1200 (650)	167 (1150)	109 (750)	—	15	—	—
		1400 (760)	123 (850)	106 (730)	—	23	—	277
	XEV-A	Room	155 (1070)	102 (700)	—	16	—	—
		1200 (650)	93 (640)	48 (330)	—	27	200	—
		1400 (760)	74 (510)	43 (300)	—	23	120	174
	XEV-B	Room	—	—	—	—	—	—
		1200 (650)	—	—	—	—	200	—
		1400 (760)	—	—	—	—	120	—
	XEV-C	Room	117 (810)	97 (670)	—	18	—	—
		1200 (650)	97 (670)	45 (310)	—	39	180	—
		1400 (760)	80 (550)	35 (240)	—	47	100	168
	XEV-D	Room	116 (800)	53 (360)	—	66	—	—
		1400 (760)	46 (320)	24 (170)	—	31	—	—
	XEV-E	Room	112 (770)	—	—	5	—	—
		1200 (650)	76 (520)	—	—	23	—	217
	XEV-F	Room	172 (1190)	127 (880)	—	6	—	—
		1200 (650)	105 (720)	82 (570)	—	8	—	—
		1400 (760)	50 (340)	40 (280)	—	13	—	—
	XEV-G	Room	162 (1120)	97 (670)	—	16	—	—
	XEV-H	Room	185 (1280)	150 (1030)	—	15	—	—
		1200 (650)	145 (1000)	125 (860)	—	12	—	240
	XEV-I	Room	154 (1060)	140 (970)	—	49	—	—