

Scraping the Code of Federal Regulations for the Commodity Flow Survey's Hazardous Materials Supplement

Krista Chan, U.S. Census Bureau

Christian Moscardi, U.S. Census Bureau

FedCASIC April 13-14, 2021

The CFS and EHM Supplement

- Commodity Flow Survey (CFS)
 - provides a comprehensive multimodal picture of national freight flows
 - cosponsored by the Bureau of Transportation Statistics (BTS) and the Census Bureau
 - Includes hazmat shippers, but not focused on them
- Expanded Hazardous Materials (EHM) supplement
 - part of CFS, but focused on hazardous materials (hazmat)
 - sponsored by Pipeline and Hazardous Materials and Safety Administration (PHMSA)

Expanded Hazardous Materials (EHM) Supplement

- Estimates by hazmat type and packaging type
 - National and possibly subnational level
- No survey currently collects detailed data on **packaging** of hazardous materials offered for transportation
- For PHMSA: determine the impact of changes to hazmat shipping rules and regulatory requirements, application of the Evidence Act

Key pieces of information we'll collect:



Type of hazmat transported.



Container used for hazmat.



Quantity/weight of hazmat.



Mode of transportation used.

The Code of Federal Regulations (CFR)

- Hazardous Materials Regulations (HMR): 49 CFR parts 171-180
- Contains all PHMSA's rules and regulations for
 - Shipment of hazmat
 - Packaging instructions and standards
 - Modes of transit
- Valuable information to support editing and imputation of survey results
- However, there are many barriers to using the CFR in its raw form

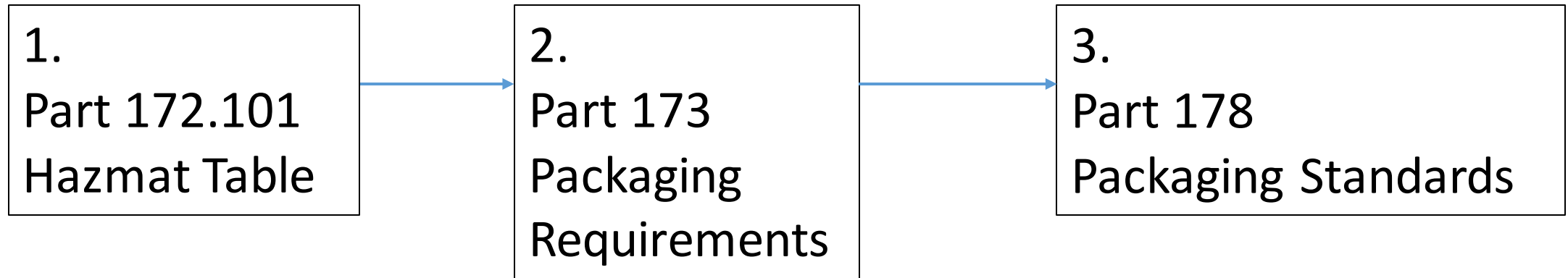


Examples of hazmat regulated by the HMR

The Problem

CFR text is highly unstructured

Key steps involved in understanding packaging regulations



- Look up United Nations/North American (UN/NA) #
- Bulk vs nonbulk requirements
- Special provisions for types of transit

- Find allowable packaging codes
- Understand pressure requirements, exceptions, inner vs outer packaging, weight restrictions

- Thorough definitions of each packaging code
- How packaging need to be tested

1. Part 172.101 Hazmat Table

UN1993 row of hazmat table

Flammable liquids, n.o.s.	3	UN1993	I	3	T11, TP1, TP27	150	2
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- Code of Federal Regulations, Title 49 § 172.101
- Hazardous Materials Table
- All hazmat have a corresponding United Nations/North American (UN/NA) number
- Respondents are asked for UN/NA numbers in the EHM
- e.g. Shippers of propane use UN1993

§ 172.101 Hazardous Materials Table

Symbols	Hazardous materials descriptions and proper shipping names	Hazard class or Division	Identification Numbers	PG	Label Codes	pro 1
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	<i>Accellerene, see p-Nitrosodimethylaniline</i>					
	<i>Accumulators, electric, see Batteries, wet etc</i>					
	<i>Accumulators, pressurized, pneumatic or hydraulic (containing non-flamable gas), see Articles pressurized, pneumatic or hydraulic (containing non-flamable gas)</i>					
	Acetal	3	UN1088	II	3	IB2,
	Acetaldehyde	3	UN1089	I	3	B18 TP2
A	Acetaldehyde ammonia	9	UN1841	III	9	IB8, T2

2. Part 173 Packaging Requirements

- Code of Federal Regulations, Title 49 § 172.101
- Hazardous Materials Table
 - All hazmat have corresponding packaging instructions
- The packaging instructions consist of dense, unstructured text

UN1993 row of hazmat table

Flammable liquids, n.o.s.	3	UN1993	I	3	T11, TP1, TP27	150	201	243
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§ 172.101 Hazardous Materials Table

Symbols	Hazardous materials descriptions and proper shipping names	Hazard class or Division	Identification Numbers	PG	Label Codes	Special provisions(§ 172.102)	(8)	Packaging(§ 173.***)	Exceptions	Non-bulk	Bulk	(9)	Quantity limitations(see §§ 173.27 and 175.75)	Passenger aircraft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(8C)	(9A)	(9B)	(10A)	(10B)	
	<i>Accellerene, see p-Nitrosodimethylaniline</i>													
	<i>Accumulators, electric, see Batteries, wet etc</i>													
	<i>Accumulators, pressurized, pneumatic or hydraulic (containing non-flammable gas), see Articles pressurized, pneumatic or hydraulic (containing non-flammable gas)</i>													
	Acetal	3	UN1088	II	3	IB2, T4, TP1	150	202	242	5 L	60 L	E		
	Acetaldehyde	3	UN1089	I	3	B16, T11, TP2, TP7	None	201	243	Forbidden	30 L	E		
A	Acetaldehyde ammonia	9	UN1841	III	9	IB8, IP3, IP7, T1, TP33	155	204	240	200 kg	200 kg	A	34	
						B1, IB3, T4								

2. Part 173 Packaging Requirements

- Where required or allowable UN/NA packaging codes are identified
- UN/NA packaging codes are asked of the respondent in the EHM and required on shipment labels

Example of packaging requirements

§ 173.201 Non-bulk packagings for liquid hazardous materials in Packing Group I.

(a) When § 172.101 of this subchapter specifies that a liquid hazardous material be packaged under this section, only non-bulk packagings prescribed in this section may be used for its transportation. Each packaging must conform to the general packaging requirements of subpart B of part 173, to the requirements of part 178 of this subchapter at the Packing Group I performance level, and to the requirements of the special provisions of column 7 of the § 172.101 table.

(b) The following combination packagings are authorized:

OUTER PACKAGINGS:

STEEL DRUM: 1A1 OR 1A2

ALUMINUM DRUM: 1B1 OR 1B2

METAL DRUM OTHER THAN STEEL OR ALUMINUM: 1N1 OR 1N2

PLYWOOD DRUM: 1D

FIBER DRUM: 1G



Required label for the shipper includes UN/NA packaging code

3. Part 178 Packaging Standards

- Where packaging codes are defined
- Users must read the table of contents to find the corresponding section

Example of packaging standards

§ 178.504 Standards for steel drums.

(a) The following are identification codes for steel drums:

- (1) 1A1 for a non-removable head steel drum; and
- (2) 1A2 for a removable head steel drum.

(b) Construction requirements for steel drums are as follows:

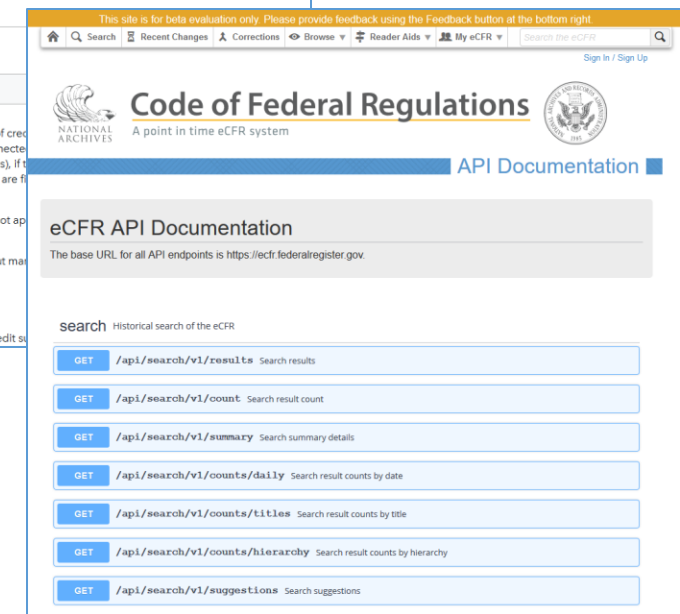
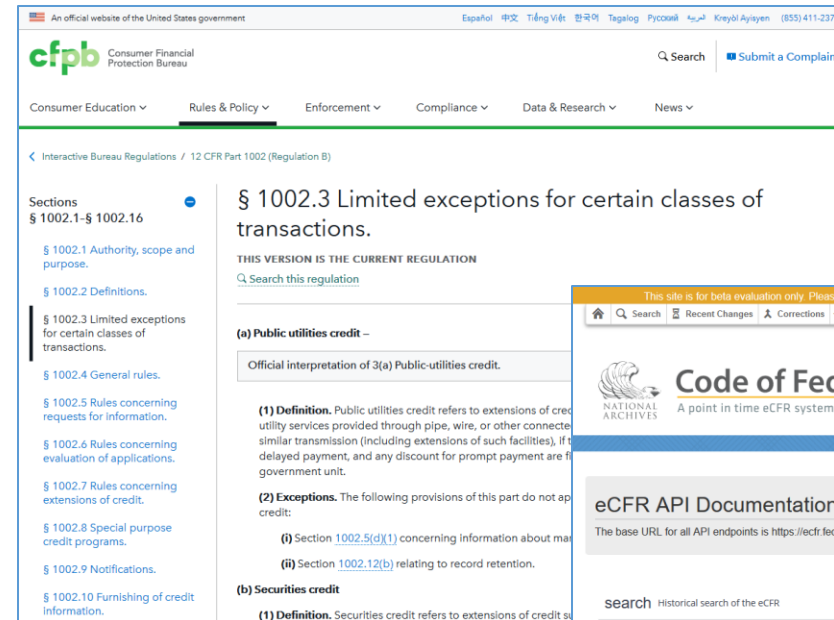
- (1) Body and heads must be constructed of steel sheet of suitable type and adequate thickness in relation to the capacity and intended use of the drum. Minimum thickness and marking requirements in §§ 173.28(b)(4) and 178.503(a)(9) of this subchapter apply to drums intended for reuse.
- (2) Body seams must be welded on drums designed to contain more than 40 L (11

The Solution

Scraping and parsing the CFR

Existing tools for navigating the CFR

- eRegs
 - Built by 18F, part of GSA
 - Key terms defined
 - Cross references
 - Changes over time
- New eCFR
 - Point in time
 - API to query parts of CFR and hierarchical relationships (chapters, subchapters, paragraphs, etc.)
- Remaining gaps:
 - Relating UN/NA numbers and packaging codes



Our solution: scraping UN/NA and packaging codes

- **Scraping** the CFR
- **Parsing** codes using regular expressions (regex)
- Loading into a relational **database**
- Create a **web app** for UN/NA querying



Tool infrastructure

CFR

1. Part 172.101
Hazmat Table

2. Part 173
Packaging
Requirements

3. Part 178
Packaging Standards

Scrape, parse

Database

Hazmat
UN/NAs

Packaging
Codes

Packaging
Standards

Query

Web App

UN/NA
form entry

Packing
instructions
with codes
highlighted

Immediate
lookup of
packaging
standards

Regular expressions (regex) example

- Regex utilizes patterns in text to **extract and structure** key information

Subpart B—Specifications for Inside Containers, and Linings

178.33	Specification 2P; inner nonrefillable metal receptacles.
178.33-1	Compliance.
178.33-2	Type and size.
178.33-3	Inspection.
178.33-4	Duties of inspector.
178.33-5	Material.
178.33-6	Manufacture.
178.33-7	Wall thickness.
178.33-8	Tests.
178.33-9	Marking.
178.33a	Specification 2Q; inner nonrefillable metal receptacles.




Part	Code	Description
178.33	2P	Inner nonrefillable metal receptacles
178.33a	2Q	Inner nonrefillable metal receptacles

Web App: UN/NA Lookup

Packaging regulations lookup

UNNA Number

Bulk Packaging? 

UN/NA search

Tooltips to define key terms

Search

Web App: UN/NA Lookup

Packaging regulations lookup

UNNA Number

Bulk Packaging? [i](#)

Select a packing group [i](#)

I

II

III

Search

Web App: Highlighted and clickable codes

Non-Bulk Packaging Instructions for UN1993 packing group I: Flammable liquids, n.o.s.

Quantity Limitations

Special Provisions

T11

TP1 The maximum degree of filling must not exceed the degree of filling determined by the following:

TP27 A portable tank having a minimum test pressure of 4 bar (400 kPa) may be used provided the calculated test pressure is 4 bar or less based on the MAWP of the hazardous material, as defined in § 178.275 of this subchapter, where the test pressure is 1.5 times the MAWP.

173.201

Click on highlighted packaging codes to view its packaging standards to the right.

(a) When § 172.101 of this subchapter specifies that a liquid hazardous material be packaged under this section, only non-bulk packagings prescribed in this section may be used for its transportation. Each packaging must conform to the general packaging requirements of subpart B of part 173, to the requirements of part 178 of this subchapter at the Packing Group I performance level, and to the requirements of the special provisions of column 7 of the § 172.101 table.

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(b) The following combination packagings are authorized:

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Outer packagings:

Steel drum: 1A1 or 1A2

Aluminum drum: 1B1 or 1B2

Highlighted packaging codes with clickable packaging standards

Packaging Standards

Pop-up with corresponding packaging standard

Web App: Highlighted and clickable codes

Non-Bulk Packaging Instructions for UN1993 packing group I: Flammable liquids, n.o.s.

Quantity Limitations

Special Provisions

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Metal drum other than steel or al

Plywood drum: 1D

Highlighted packaging codes with clickable packaging standards

Packaging Standards

178.504

(a) The following are identification codes for steel drums:

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- (2) 1A2 for a removable head steel drum.

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- (1) Body and heads must be constructed of steel sheet of suitable type and adequate thickness in relation to the capacity and intended use of the drum. Minimum thickness and marking requirements in §§ 173.28(b)(4) and 178.503(a)(9) of this subchapter apply to drums intended for reuse.
- (2) Body seams must be welded on drums designed to contain more than 40 L (11 gallons) of liquids. Body seams must be mechanically seamed or welded on drums intended to contain only solids or 40 L (11 gallons) or less of liquids.
- (3) Chimes must be mechanically seamed or welded. Separate reinforcing rings may be applied.
- (4) The body of a drum of a capacity greater than 60 L (16 gallons) may have at least two expanded rolling hoops or two separate rolling hoops. If there are separate rolling hoops, they must be fitted tightly on the body and so secured that they cannot shift. Rolling hoops may not be spot-welded.

Pop-up with corresponding packaging standard

EHM Survey Process

- Rapid verification of respondent entries against regulation during survey editing
- Automated parsing and matching of free-response packaging code text
- Imputing based on regulations where respondents do not answer



- Reduced analyst burden
- Improved data quality

Future work

- Named entity recognition*
 - Identifying chemical names and where they were mentioned
- Training a model to recognize conditional authorizations in text*
- Plugging into eCFR
- More querying options

Potential Applications

- Parsing codes within regulations (NAICS, VIN #s, etc.)
- Quick querying of the CFR by a certain topic or theme
- Quantitative analysis of regulations

Questions?

Email: Krista.c.chan@census.gov

Project Github: <https://github.com/census-bds/usdot-phmsa-hazmat-parser>