Exhibit 14-

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2022-08-14

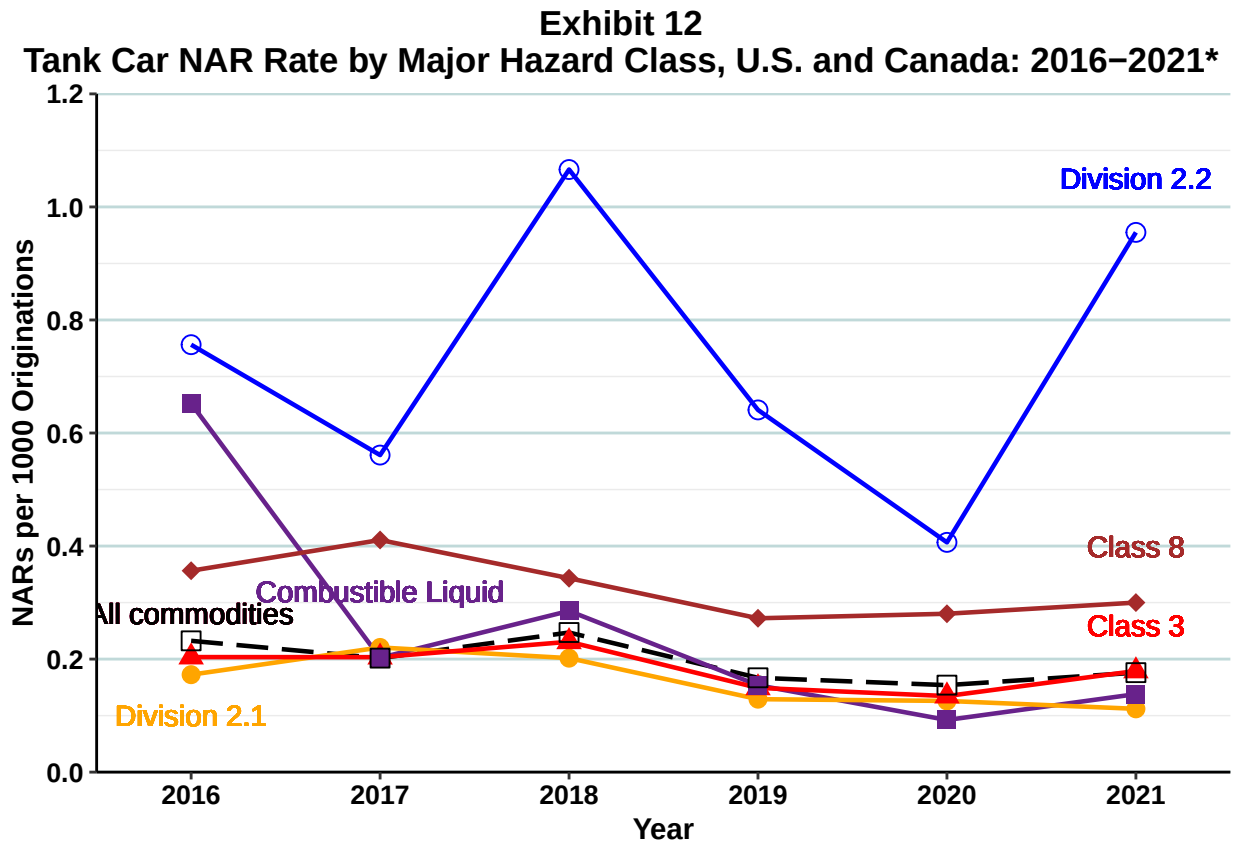
```
## datas
year = 2021
TRAFFIC = 'Traffic 2021.xlsx'
```

```
Exh_11_str = read.xlsx("Exh_11.xlsx")
```

```
## New names:
## * `` -> ...2
## * `` -> ...4
## * `` -> ...5
## * `` -> ...6
## * `` -> ...7
## * ...
```

```
#Plot
Exh_12_plot = ggplot(data = df12_1, aes(x = Year, y = value, color = type, linetype = type))+
  geom_line(size = 0.8)+
  geom_point(aes(shape=type), size=3)+
  scale_shape_manual(values = c(`Hazard Class 2.1` = 16, `Hazard Class 2.2` = 21, `Hazard Class 3` = 17
  scale_linetype_manual(values = c(`Hazard Class 2.1` = "solid", `Hazard Class 2.2` = "solid", `Hazard C
  scale_color_manual(values = c(`Hazard Class 2.1` = "orange", `Hazard Class 2.2` = "blue", `Hazard Clas
  labs(title = "Exhibit 12\nTank Car NAR Rate by Major Hazard Class, U.S. and Canada: 2016-2021*")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  theme(panel.grid.major.x=element_blank(),panel.grid.minor.x=element_blank(),
        panel.grid.major = element_line(colour = "#C0D9D9"))+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  scale_y_continuous("NARs per 1000 Originations",limits = c(0,1.2),breaks = seq(0,1.2,0.2),expand = c(0
  scale_x_continuous("Year",limits = c(year-5.5,year+0.5),breaks = seq(year-5,year,1),expand = c(0,0))+
  #Manual add text. Need change position every year!!!!
  geom_text(x = 2021, y = 1.05, label = "Division 2.2", color = "blue")+
  geom_text(x = 2021, y = 0.4, label = "Class 8", color = "brown")+
  geom_text(x = 2017, y = 0.32, label = "Combustible Liquid", color = "darkorchid4")+
  geom_text(x = 2016, y = 0.28, label = "All commodities")+
  geom_text(x = 2021, y = 0.26, label = "Class 3", color = "red")+
```

```
  geom_text(x = 2016, y = 0.1, label = "Division 2.1", color = "orange")

Exh_12_plot
```



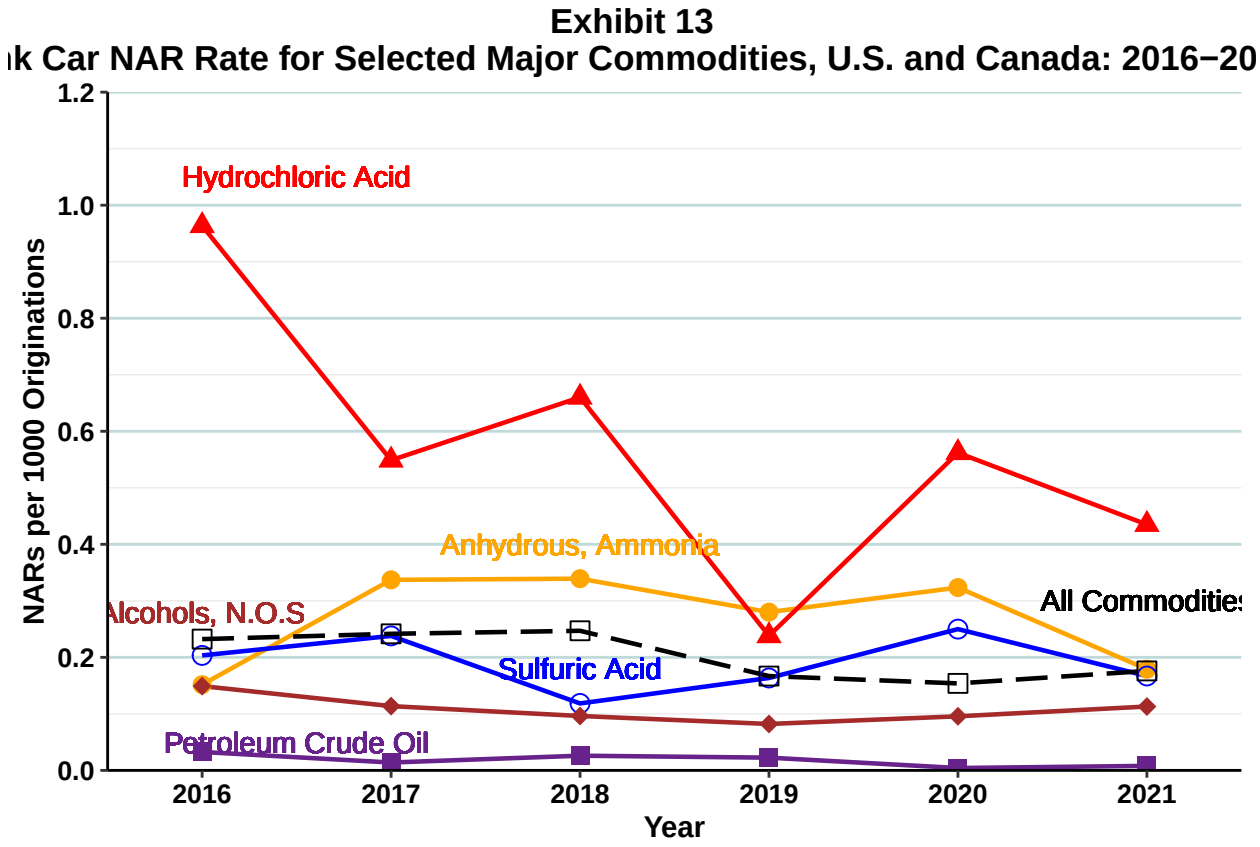

```
#ggsave("Exh_12_plot.png")
```

```
df13 = read_excel('Exhibit 11-13.xlsx',sheet = "Exh13 updated")
```

```
## New names:
## * `` -> ...1
## * `` -> ...2
## * `` -> ...4
## * `` -> ...5
## * `` -> ...6
## * ...
```

```
df13 = df13[c(2:11),]
colnames(df13) = c(" ",seq(2011,year))
df13 = cbind(df13,Exh_13)
#Output new dataframe df13
df13 = as.data.frame(t(df13))
df13 = df13[-1,]
df13 = df13[,c(2,4,5,6,7,8)]
df13 = df13%>%
```

```
  mutate(Year = c(seq(2011,year)))
df13 = df13%>%
  gather(key = "type", value = "value", -Year)
df13$Year = as.numeric(df13$Year)
df13$value = as.numeric(df13$value)
df13_1 = df13%>%
  filter(Year >= year -5)
df13_2 = df13%>%
  filter(Year < year -5)

#Plot
Exh_13_plot = ggplot(data = df13_1, aes(x = Year, y = value, color = type, linetype = type))+
  geom_line(size = 0.8)+
  geom_point(aes(shape=type), size=3)+
  scale_shape_manual(values = c(Ammonia = 16, Sulfuric = 21, Hydrochloric = 17, Alcohols = 18, `Total U
  scale_linetype_manual(values = c(Ammonia = "solid", Sulfuric = "solid", Hydrochloric = "solid", Alcoh
  scale_color_manual(values = c(Ammonia = "orange", Sulfuric = "blue", Hydrochloric = "red", Alcohols =
  labs(title = "Exhibit 13\nTank Car NAR Rate for Selected Major Commodities, U.S. and Canada: 2016-202
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  theme(panel.grid.major.x=element_blank(),panel.grid.minor.x=element_blank(),
        panel.grid.major = element_line(colour = "#C0D9D9"))+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  scale_y_continuous("NARs per 1000 Originations",limits = c(0,1.2),breaks = seq(0,1.2,0.2),expand = c(0
  scale_x_continuous("Year",limits = c(year-5.5,year+0.5),breaks = seq(year-5,year,1),expand = c(0,0))+
  #Manual add text. Need change position every year!!!!
  geom_text(x = 2018, y = 0.18, label = "Sulfuric Acid", color = "blue")+
  geom_text(x = 2021, y = 0.3, label = "All Commodities", color = "black")+
  geom_text(x = 2016.5, y = 0.05, label = "Petroleum Crude Oil", color = "darkorchid4")+
  geom_text(x = 2016, y = 0.28, label = "Alcohols, N.O.S", color = "brown")+
  geom_text(x = 2016.5, y = 1.05, label = "Hydrochloric Acid", color = "red")+
  geom_text(x = 2018, y = 0.4, label = "Anhydrous, Ammonia", color = "orange")

Exh_13_plot
```




```
##############################Get all the cause code#################################
Exh_14_tank = df%>%
  filter(Cartype == 'Tank Car')

code14_1 = Exh_14_tank[,c(10,11,16,22)]
code14_2 = Exh_14_tank[,c(10,11,16,23)]
code14_3 = Exh_14_tank[,c(10,11,16,24)]
colnames(code14_1) = c("PSN","UNNA","Spec","Cause Code")
colnames(code14_2) = c("PSN","UNNA","Spec","Cause Code")
colnames(code14_3) = c("PSN","UNNA","Spec","Cause Code")
new14 = rbind(code14_1,code14_2,code14_3)

#Merge by the following cause
Exh_14_raw = merge(df_14,new14,"Cause Code")
```

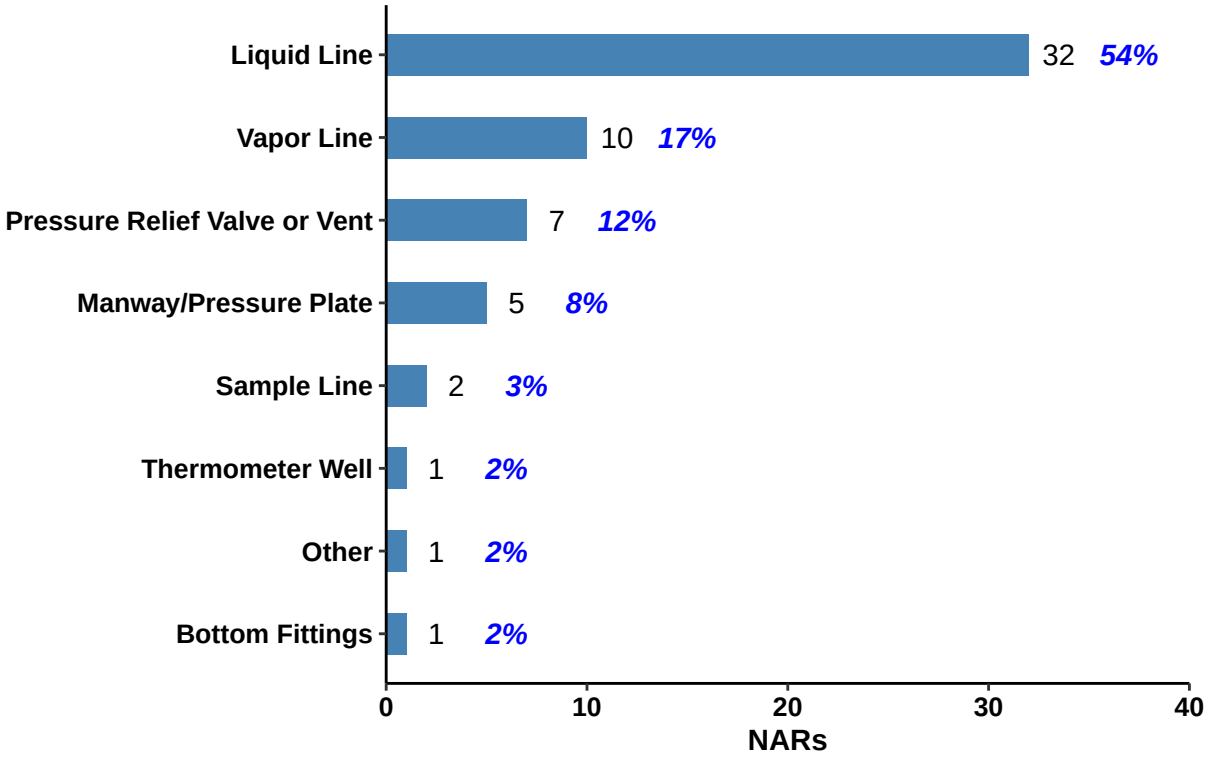
#Write before barplot 1. The position of text should change according to the length of bar. (Change 'nudge_y') 2. Change the year in the title. 3. Notice some of the percent data like "0.3%" should change number in scales::percent(x,number). Like 1 means 1%, 0.1 means 0.1%

```
#Distinguish Pressure and Non-Pressure
pressure_car = Exh_14_raw%>%
  filter(str_detect(Spec,paste(c("^105","^112","^114","^120"),collapse = "|")))
non_pressure_car = Exh_14_raw%>%
  filter(str_detect(Spec,paste(c("^111","^115","^117","^211"),collapse = "|")))
```

```
neither_car = Exh_14_raw%>%
  filter(str_detect(Spec,"^113"))
#Filter the data
Exh_15 = pressure_car%>%
  group_by(`Source (Exhibit 14 of the BOE Leak)`)%>%
  count()%>%
  mutate(percent = round(n/nrow(pressure_car),2))%>%
  arrange(n)
Exh_15$percent = scales::percent(Exh_15$percent,1)
```

```
#Plot
ggplot(data = Exh_15, aes(x = reorder(Exh_15$`Source (Exhibit 14 of the BOE Leak)`,n) ,y = Exh_15$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 15\nNumber of Pressure Tank Car NARs by Component*, U.S. and Canada: 2020")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,40),breaks = seq(0,40,10),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 1.5,size = 4)+
  geom_text(aes(label = percent),nudge_y= 5,size = 4, color = "blue", fontface="bold.italic")
```

Exhibit 15
Number of Pressure Tank Car NARs by Component*, U.S. and Canada: 2020

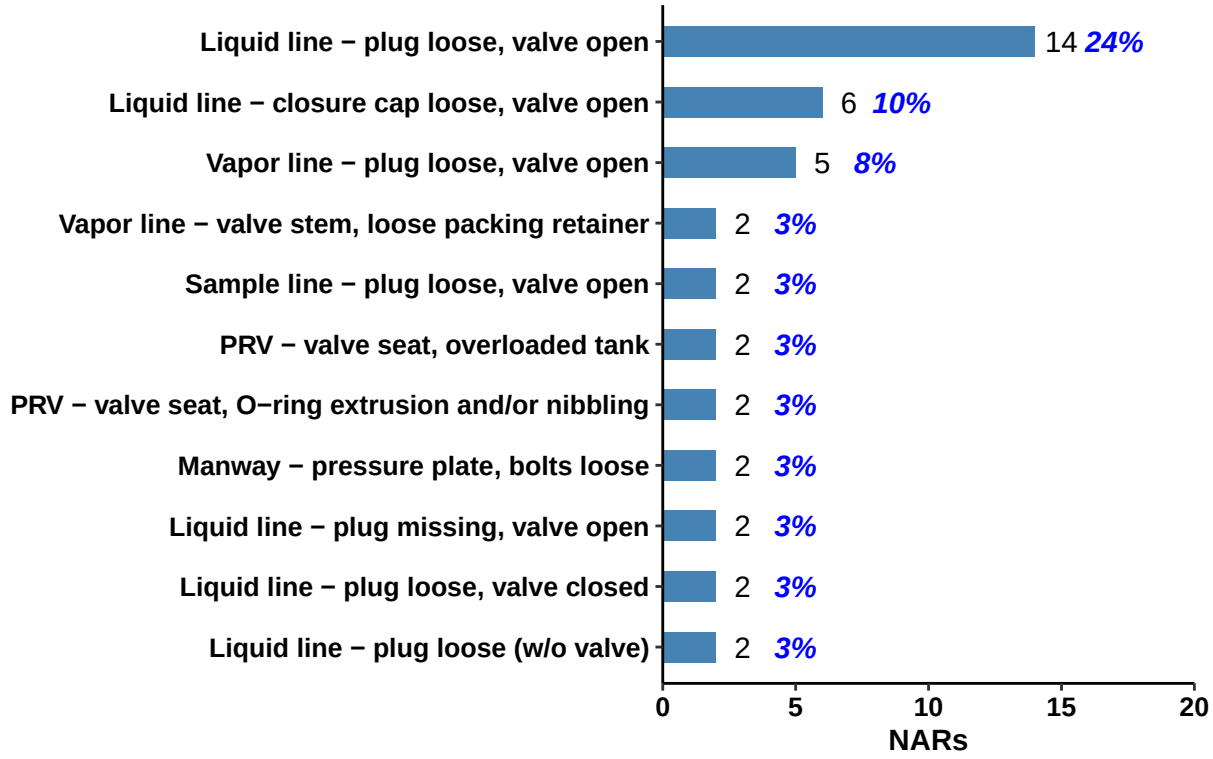



```
Exh_16 = pressure_car%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(percent = round(n/nrow(pressure_car),2))%>%
  arrange(desc(n))
Exh_16$percent = scales::percent(Exh_16$percent,1)
```

```
#Exhibit plot use name like df+num means some of the number don't need to show in the plot.
#So be careful about this and change the number in the head function every time you run the code!
df16 = Exh_16%>%
  head(11)

ggplot(data = df16, aes(x = reorder(df16$`Name for Exhibits`,n) ,y = df16$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 16\nTop Reported NAR Causes for Pressure Tank Cars*, U.S. and Canada: 2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,20),breaks = seq(0,20,5),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
```

```
  theme(panel.border = element_blank())+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 1,size = 4)+
  geom_text(aes(label = percent),nudge_y= 3,size = 4, color = "blue", fontface="bold.italic")
```

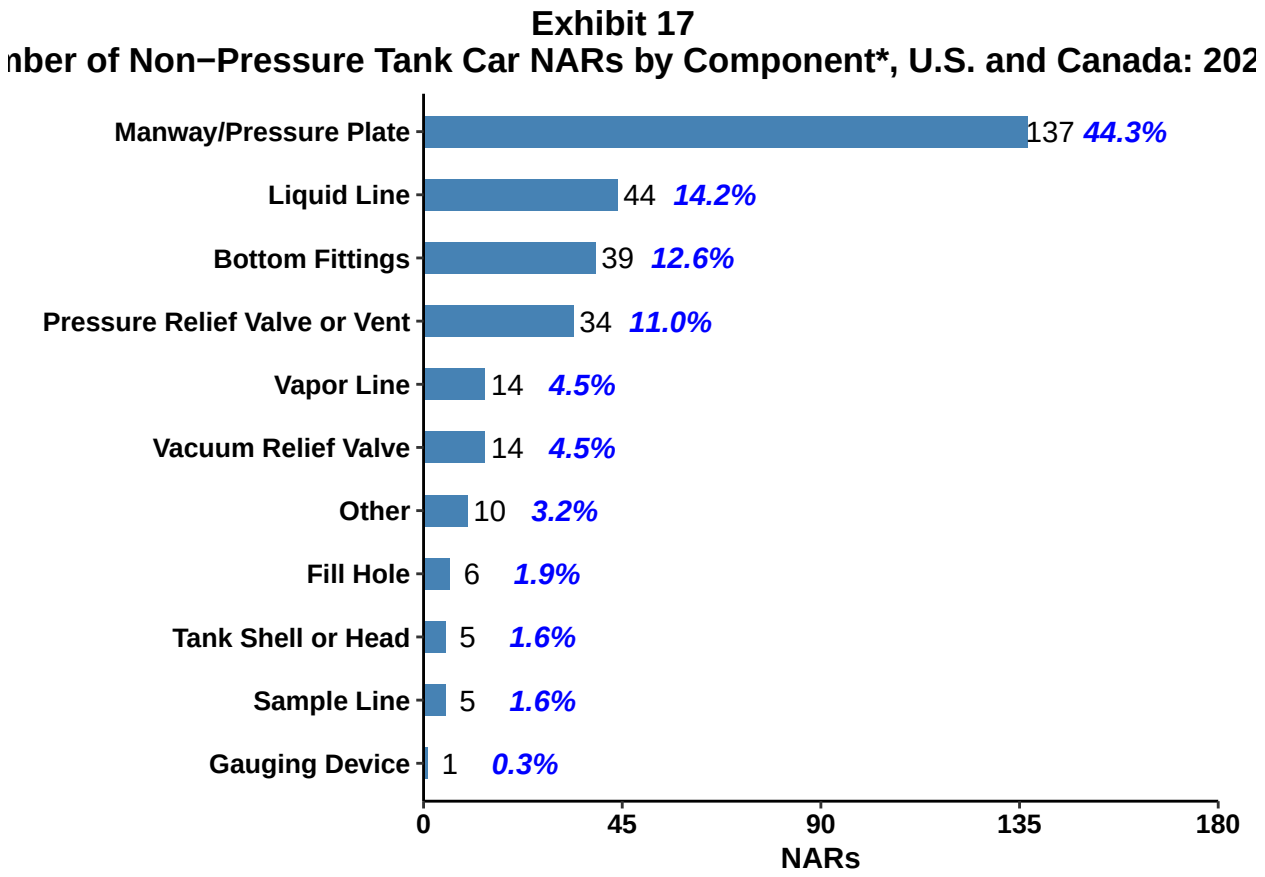
Exhibit 16
Top Reported NAR Causes for Pressure Tank Cars*, U.S. and Canada: 2021




```
Exh_17 = non_pressure_car%>%
  group_by(`Source (Exhibit 14 of the BOE Leak)`)%>%
  count()%>%
  mutate(percent = round(n/nrow(non_pressure_car),3))%>%
  arrange(desc(n))
Exh_17$percent = scales::percent(Exh_17$percent,0.1)
```

```
ggplot(data = Exh_17, aes(x = reorder(Exh_17$`Source (Exhibit 14 of the BOE Leak)`,n) ,y = Exh_17$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 17\nNumber of Non-Pressure Tank Car NARs by Component*, U.S. and Canada: 2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,180),breaks = seq(0,180,45),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
```

```
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  theme(plot.margin = margin(0,0.5,0,0, "cm"))+
  geom_text(aes(label = n),nudge_y= 5,size = 4)+
  geom_text(aes(label = percent),nudge_y= 22,size = 4, color = "blue", fontface="bold.italic")
```

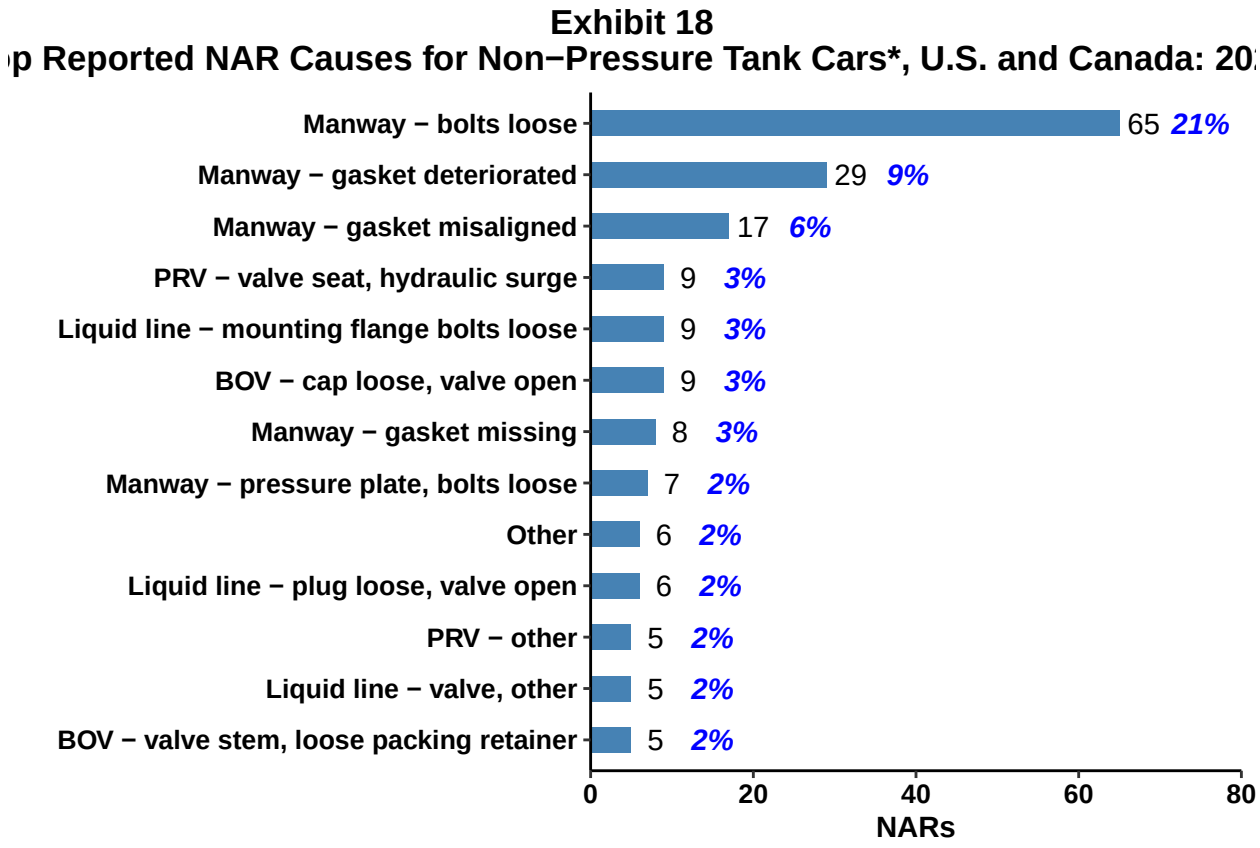



```
#ggsave("Exh_17_plot.png")
```

```
Exh_18 = non_pressure_car%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(percent = round(n/nrow(non_pressure_car),2))%>%
  arrange(desc(n))
Exh_18$percent = scales::percent(Exh_18$percent,1)
```

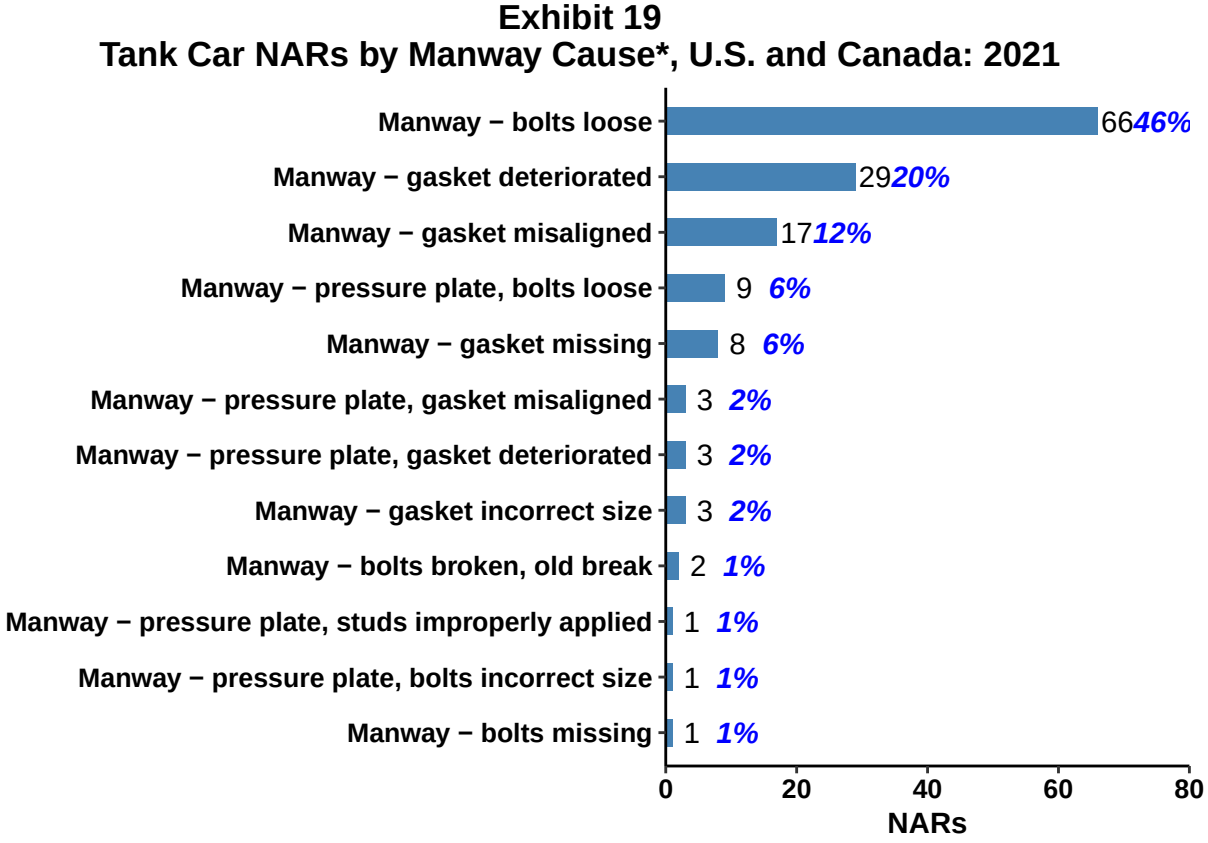
```
df18 = Exh_18%>%
  head(13)

ggplot(data = df18, aes(x = reorder(df18$`Name for Exhibits`,n) ,y = df18$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 18\nTop Reported NAR Causes for Non-Pressure Tank Cars*, U.S. and Canada: 2021"
  theme_bw()+
```

```
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,80),breaks = seq(0,80,20),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 3,size = 4)+
  geom_text(aes(label = percent),nudge_y= 10,size = 4, color = "blue", fontface="bold.italic")
```




```
Exh_19_total = nrow(Exh_14_raw%>%
  filter(`Source (Exhibit 14 of the BOE Leak)`== 'Manway/Pressure Plate'))

Exh_19 = Exh_14_raw%>%
  filter(`Source (Exhibit 14 of the BOE Leak)`== 'Manway/Pressure Plate')%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_19_total,2))%>%
  arrange(desc(n))
Exh_19$per = scales::percent(Exh_19$per,1)
```

```
ggplot(data = Exh_19, aes(x = reorder(Exh_19$`Name for Exhibits`,n) ,y = Exh_19$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 19\nTank Car NARs by Manway Cause*, U.S. and Canada: 2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,80),breaks = seq(0,80,20),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 3,size = 4)+
  geom_text(aes(label = per),nudge_y= 10,size = 4, color = "blue", fontface="bold.italic")
```

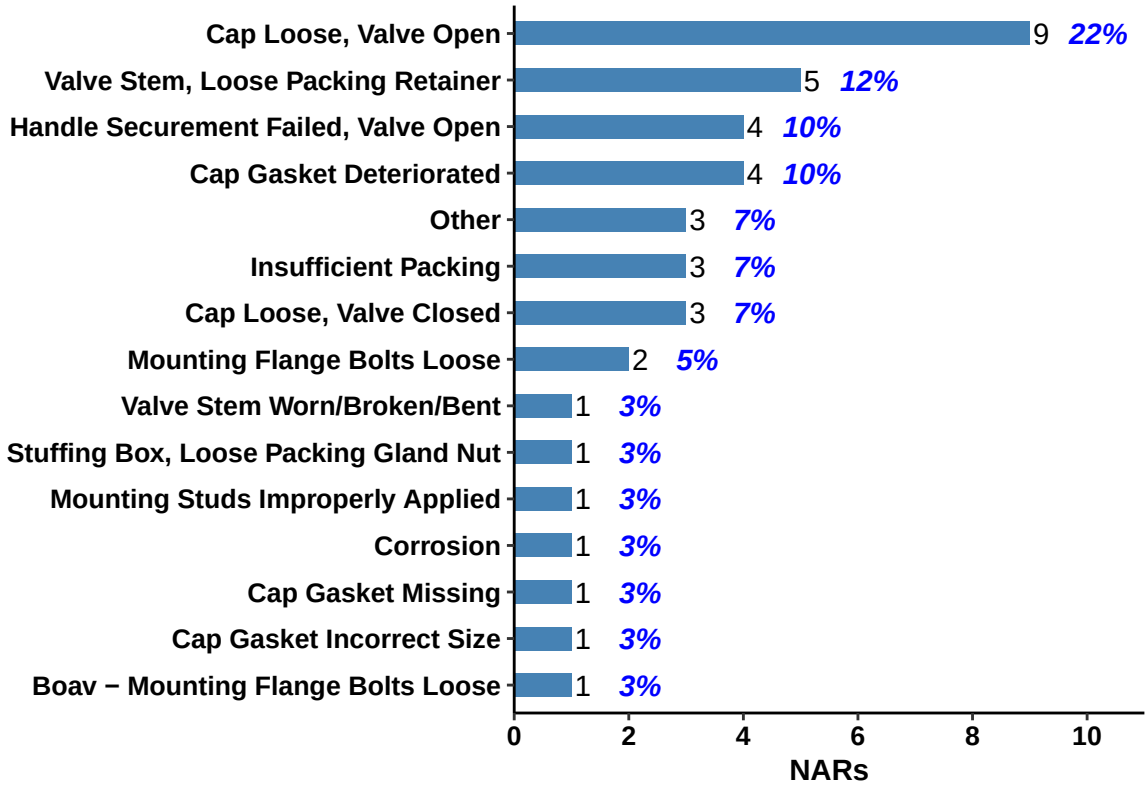



```
Exh_20_total = nrow(Exh_14_raw%>%
  filter(`Source (Exhibit 14 of the BOE Leak)`== 'Bottom Fittings'))

Exh_20 = Exh_14_raw%>%
  filter(`Source (Exhibit 14 of the BOE Leak)`== 'Bottom Fittings')%>%
  group_by(`Name for Exhibits`)%>%
```

```
  count()%>%
  mutate(per = round(n/Exh_20_total,2))%>%
  arrange(desc(n))
Exh_20$per = scales::percent(Exh_20$per,1)
Exh_20$`Name for Exhibits` = str_remove(Exh_20$`Name for Exhibits`,'BOV - ')
Exh_20$`Name for Exhibits` = str_to_title(Exh_20$`Name for Exhibits`)
```

```
ggplot(data = Exh_20, aes(x = reorder(Exh_20$`Name for Exhibits`,n) ,y = Exh_20$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 20\nTank Car NARs by Bottom Outlet Cause*, U.S. and Canada: 2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,11),breaks = seq(0,11,2),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.2,size = 4)+
  geom_text(aes(label = per),nudge_y= 1.2,size = 4, color = "blue", fontface="bold.italic")
```

Exhibit 20
Tank Car NARs by Bottom Outlet Cause*, U.S. and Canada: 2021

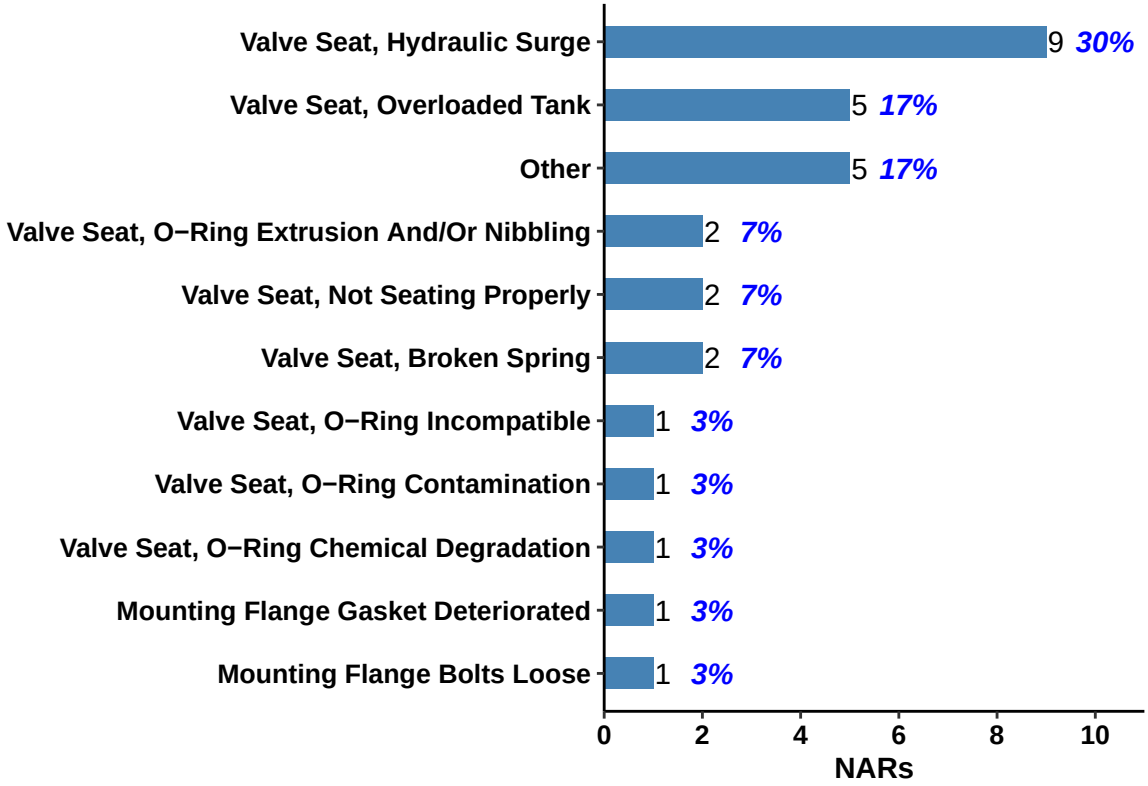



```
Exh_21_total = nrow(Exh_14_raw%>%
  filter(str_detect(`Name for Exhibits`,"^PRV")))

Exh_21 = Exh_14_raw%>%
  filter(str_detect(`Name for Exhibits`,"^PRV"))%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_21_total,2))%>%
  arrange(desc(n))
Exh_21$per = scales::percent(Exh_21$per,1)
Exh_21$`Name for Exhibits` = str_remove(Exh_21$`Name for Exhibits`,'PRV - ')
Exh_21$`Name for Exhibits` = str_to_title(Exh_21$`Name for Exhibits`)
```

```
ggplot(data = Exh_21, aes(x = reorder(Exh_21$`Name for Exhibits`,n) ,y = Exh_21$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 21\nTank Car NARs by Pressure Relief Valve Cause*, U.S. and Canada: 2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,11),breaks = seq(0,11,2),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
```

```
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.2,size = 4)+
  geom_text(aes(label = per),nudge_y= 1.2,size = 4, color = "blue", fontface="bold.italic")
```

Exhibit 21
Tank Car NARs by Pressure Relief Valve Cause*, U.S. and Canada: 2021

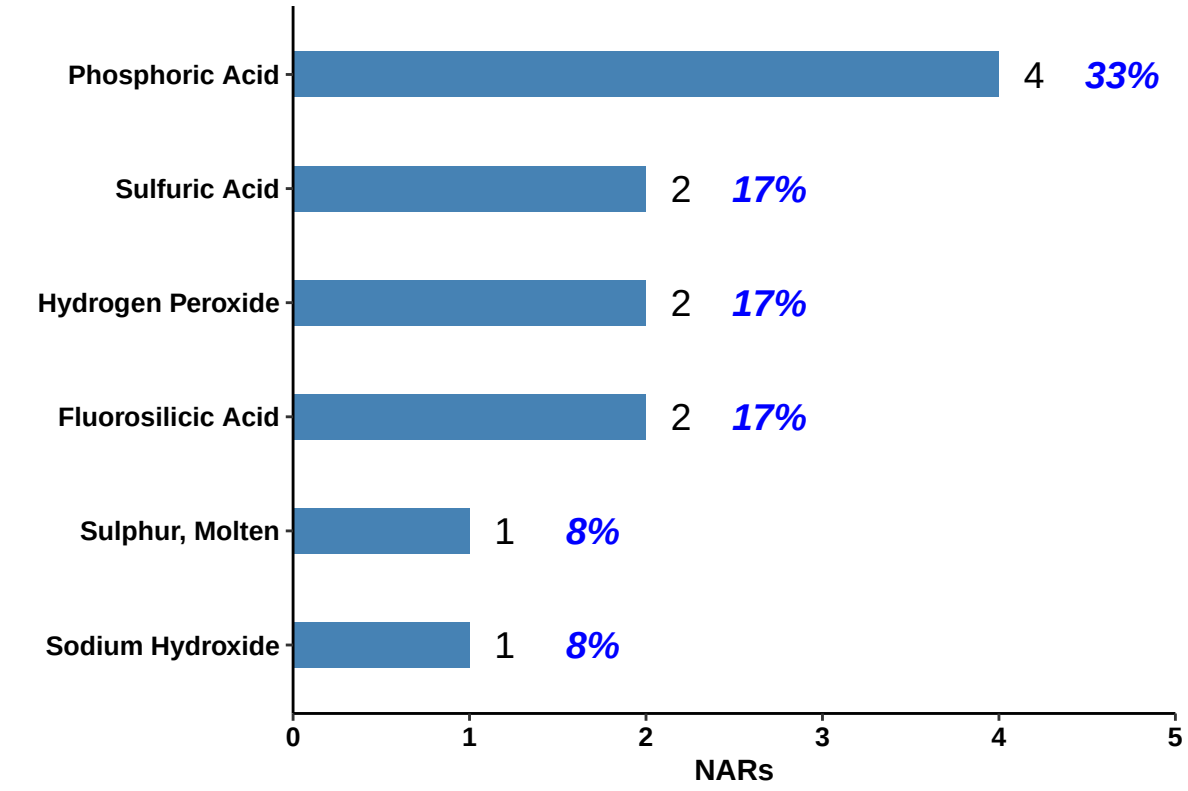



```
Exh_22_total = nrow(Exh_14_raw%>%
  filter(str_detect(`Name for Exhibits`,"^Safety vent")))

Exh_22 = Exh_14_raw%>%
  filter(str_detect(`Name for Exhibits`,"^Safety vent"))%>%
  group_by(PSN)%>%
  count()%>%
  mutate(per = round(n/Exh_22_total,2))%>%
  arrange(desc(n))
Exh_22$per = scales::percent(Exh_22$per,1)
```

```
ggplot(data = Exh_22, aes(x = reorder(Exh_22$PSN,n) ,y = Exh_22$n))+
  geom_bar(stat="identity", width = 0.4, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 22\nSafety-Vent-Caused Tank Car NARs by Commodity*, U.S. and Canada: 2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
```

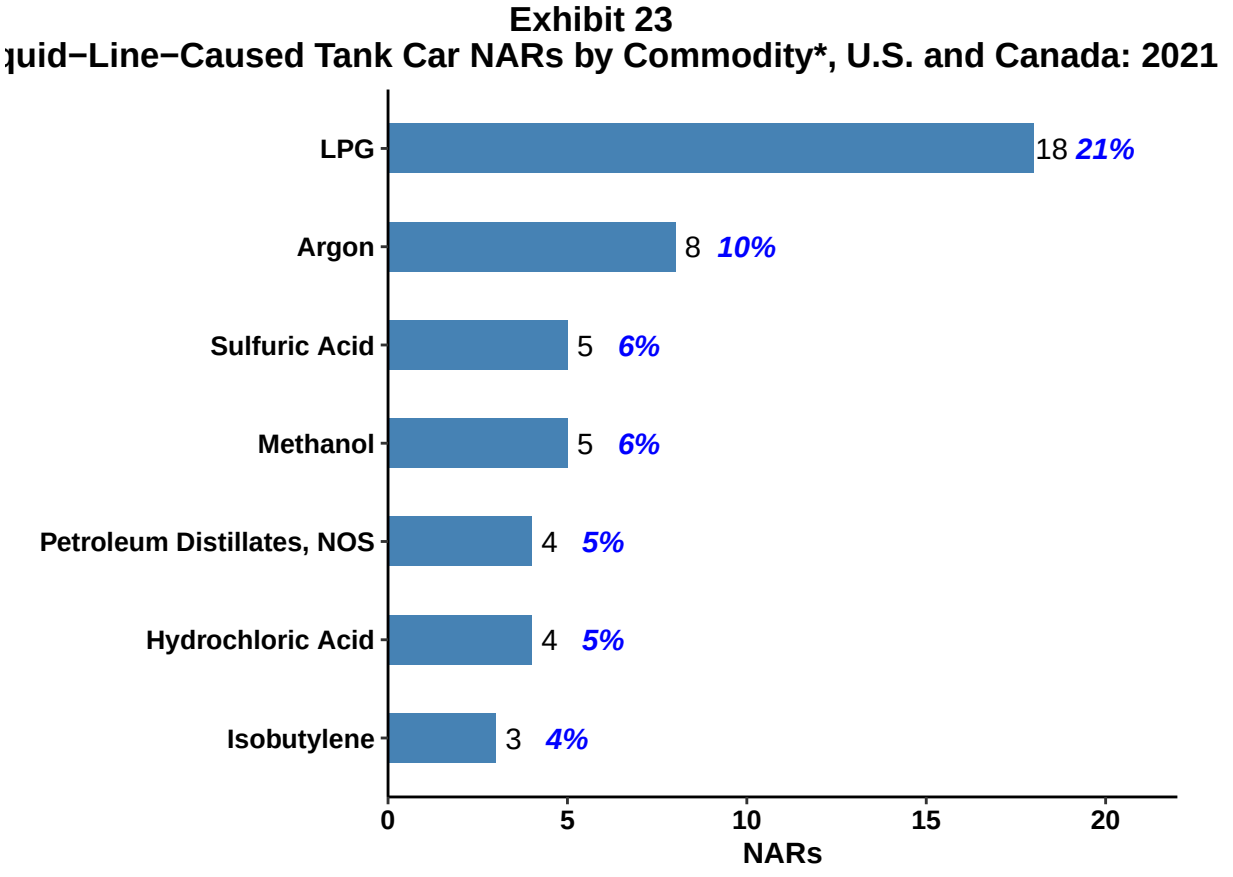
```
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,5),breaks = seq(0,5,1),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.2,size = 5)+
  geom_text(aes(label = per),nudge_y= 0.7,size = 5, color = "blue", fontface="bold.italic")
```

Exhibit 22
fety−Vent−Caused Tank Car NARs by Commodity*, U.S. and Canada: 2021




```
Exh_23_total = nrow(Exh_14_raw%>%
  filter(str_detect(`Name for Exhibits`,"^Liquid line")))

Exh_23 = Exh_14_raw%>%
  filter(str_detect(`Name for Exhibits`,"^Liquid line"))%>%
  group_by(PSN)%>%
  count()%>%
  mutate(per = round(n/Exh_23_total,2))%>%
  arrange(desc(n))
Exh_23$per = scales::percent(Exh_23$per,1)
```

```
df23 = Exh_23%>%
  head(7)

ggplot(data = df23, aes(x = reorder(df23$PSN,n) ,y = df23$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 23\nLiquid-Line-Caused Tank Car NARs by Commodity*, U.S. and Canada: 2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,22),breaks = seq(0,22,5),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.5,size = 4)+
  geom_text(aes(label = per),nudge_y= 2,size = 4, color = "blue", fontface="bold.italic")
```

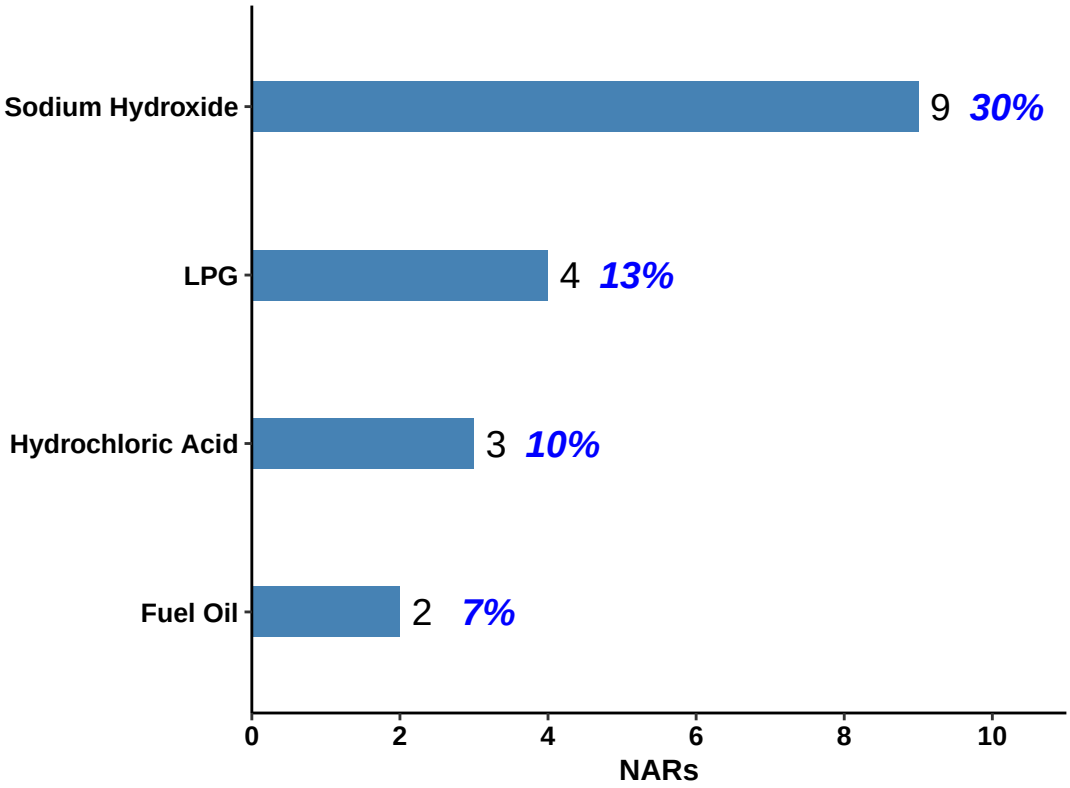



```
Exh_24_total = nrow(Exh_14_raw%>%
  filter(str_detect(`Name for Exhibits`,"^PRV")))
```

```
Exh_24 = Exh_14_raw%>%
  filter(str_detect(`Name for Exhibits`,"^PRV"))%>%
  group_by(PSN)%>%
  count()%>%
  mutate(per = round(n/Exh_24_total,2))%>%
  arrange(desc(n))
Exh_24$per = scales::percent(Exh_24$per,1)
```

```
df24 = Exh_24%>%
  head(4)

ggplot(data = df24, aes(x = reorder(df24$PSN,n) ,y = df24$n))+
  geom_bar(stat="identity", width = 0.3, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 24\nPressure Relief Valve-Caused Tank Car NARs by Commodity*, U.S. and Canada: 1
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,11),breaks = seq(0,11,2),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,1,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.3,size = 5)+
  geom_text(aes(label = per),nudge_y= 1.2,size = 5, color = "blue", fontface="bold.italic")
```

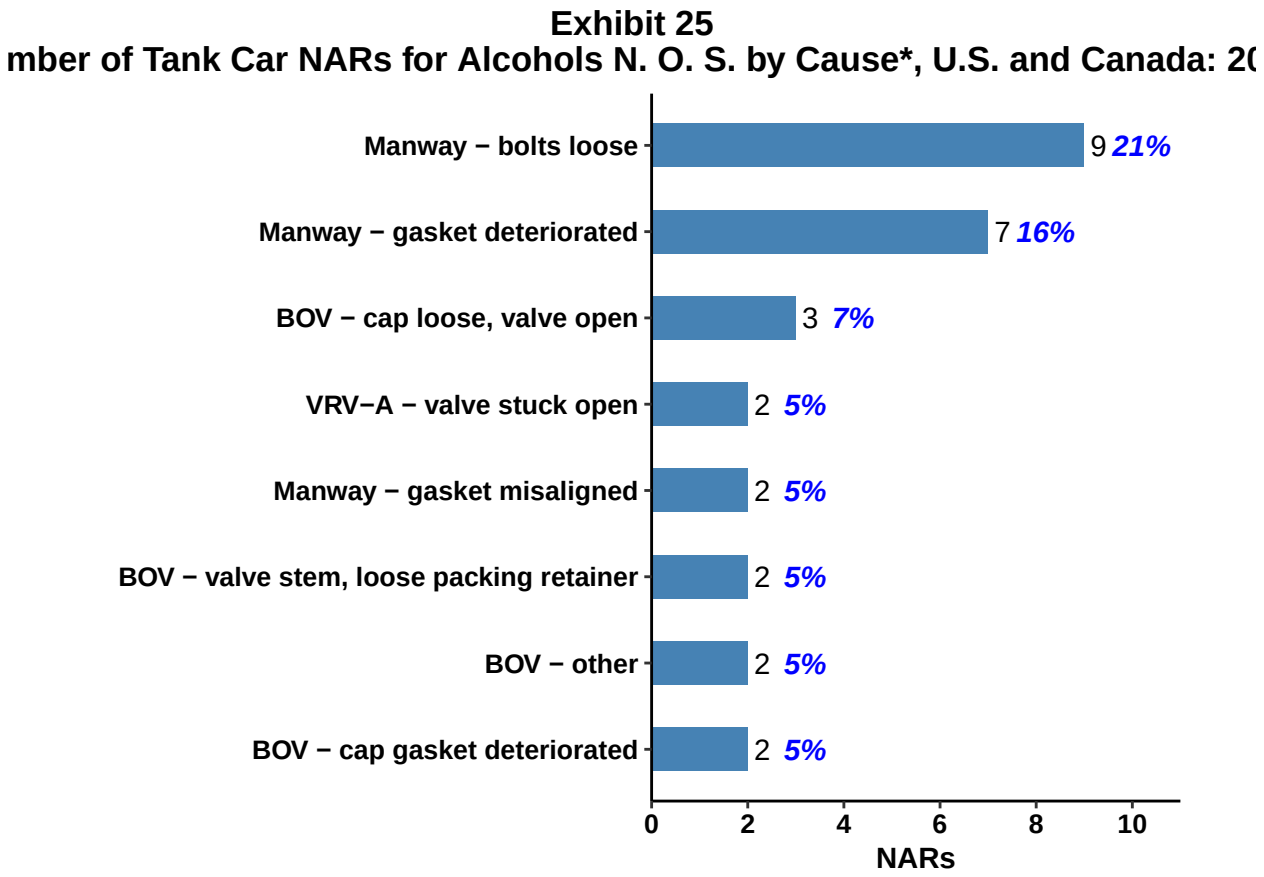
Exhibit 24
sure Relief Valve−Caused Tank Car NARs by Commodity*, U.S. and Canada:




```
Exh_25_total = nrow(new14%>%
  filter(PSN == "Alcohols, NOS" & `Cause Code` != 'NA'))

Exh_25 = Exh_14_raw%>%
  filter(PSN == "Alcohols, NOS")%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_25_total,2))%>%
  arrange(desc(n))
Exh_25$per = scales::percent(Exh_25$per,1)
```

```
df25 = Exh_25%>%
  head(8)

ggplot(data = df25, aes(x = reorder(df25$`Name for Exhibits`,n) ,y = df25$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 25\nNumber of Tank Car NARs for Alcohols N. O. S. by Cause*, U.S. and Canada: 2
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
```

```
  scale_y_continuous("NARs",limits = c(0,11),breaks = seq(0,11,2),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,1,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.3,size = 4)+
  geom_text(aes(label = per),nudge_y= 1.2,size = 4, color = "blue", fontface="bold.italic")
```



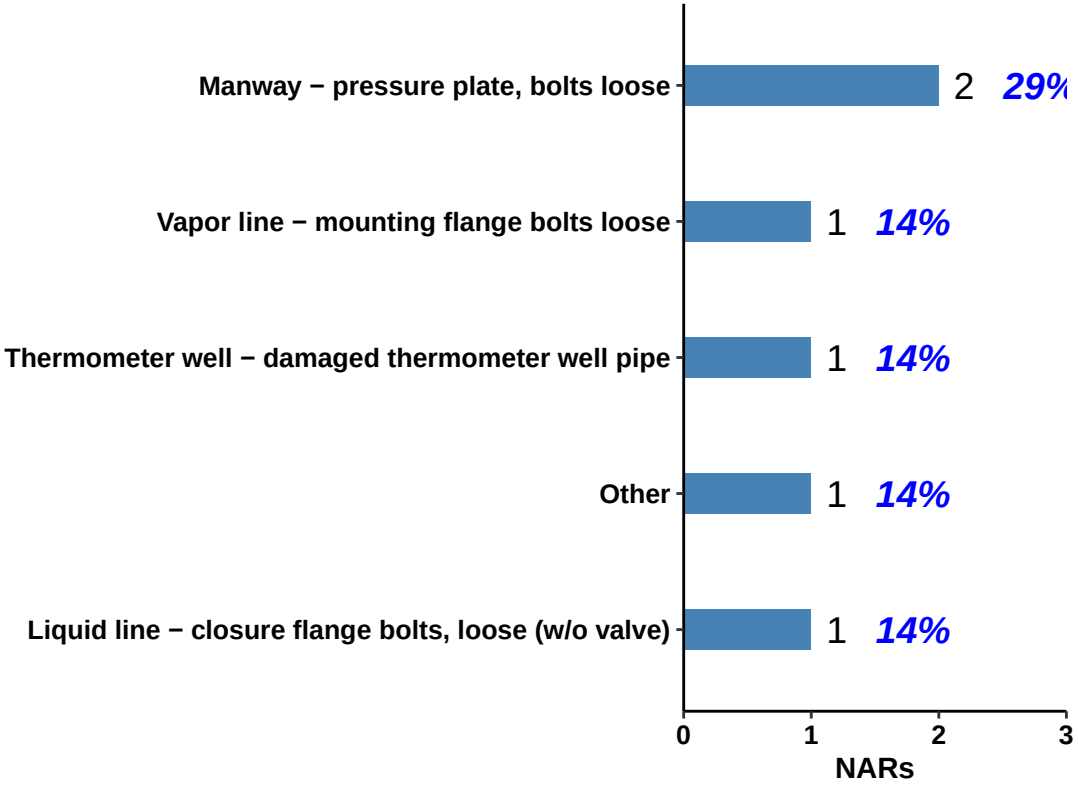

```
Exh_26_total = nrow(new14%>%
  filter(PSN == "Ammonia Anhydrous" & `Cause Code` != 'NA'))

Exh_26 = Exh_14_raw%>%
  filter(PSN == "Ammonia Anhydrous")%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_26_total,2))%>%
  arrange(desc(n))
Exh_26$per = scales::percent(Exh_26$per,1)
```

```
ggplot(data = Exh_26, aes(x = reorder(Exh_26$`Name for Exhibits`,n) ,y = Exh_26$n))+
  geom_bar(stat="identity", width = 0.3, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 26\nNumber of Tank Car NARs for Anhydrous Ammonia by Cause*, U.S. and Canada: 2
  theme_bw()+
```

```
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,3),breaks = seq(0,3,1),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,1,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.2,size = 5)+
  geom_text(aes(label = per),nudge_y= 0.8,size = 5, color = "blue", fontface="bold.italic")
```

Exhibit 26

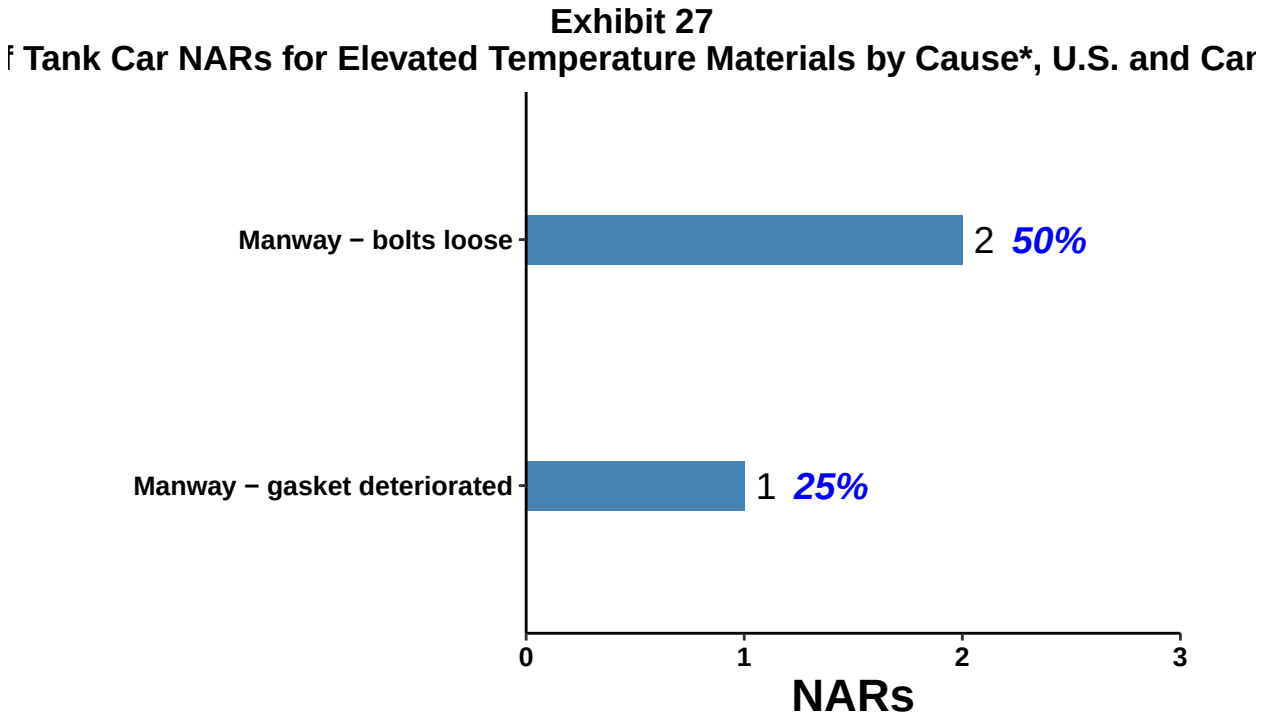
ber of Tank Car NARs for Anhydrous Ammonia by Cause*, U.S. and Canada:




```
Exh_27_total = nrow(new14%>%
  filter(PSN == "ETM" & `Cause Code` != 'NA'))

Exh_27 = Exh_14_raw%>%
  filter(PSN == "ETM")%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_27_total,2))%>%
  arrange(desc(n))
```

```
Exh_27$per = scales::percent(Exh_27$per,1)
```

```
ggplot(data = Exh_27, aes(x = reorder(Exh_27$`Name for Exhibits`,n) ,y = Exh_27$n))+
  geom_bar(stat="identity", width = 0.2, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 27\nNumber of Tank Car NARs for Elevated Temperature Materials by Cause*, U.S. a
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1.5), face = "bold"),
        axis.title.y = element_text(size = rel(1.5), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,3),breaks = seq(0,3,1),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(1,1,1,1,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.1,size = 5)+
  geom_text(aes(label = per),nudge_y= 0.4,size = 5, color = "blue", fontface="bold.italic")
```

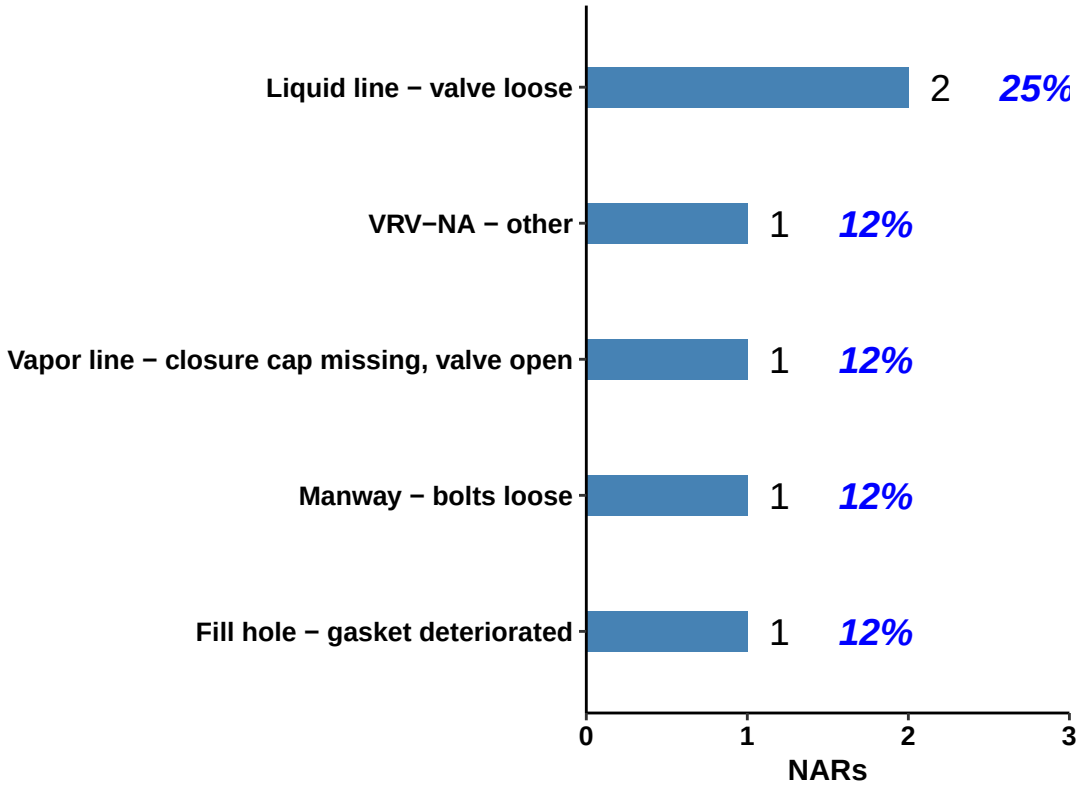



```
#Remeber ggsave can modify the size of picture which is different from what we seen in Rstudio
#ggsave("Exh_27.png", width = 10, height = 5)
```

```
Exh_28_total = nrow(new14%>%
  filter(UNNA == "UN1203" & `Cause Code` != 'NA'))

Exh_28 = Exh_14_raw%>%
  filter(UNNA == "UN1203")%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_28_total,2))%>%
  arrange(desc(n))

Exh_28$per = scales::percent(Exh_28$per,1)
```

```
ggplot(data = Exh_28, aes(x = reorder(Exh_28$`Name for Exhibits`,n) ,y = Exh_28$n))+
  geom_bar(stat="identity", width = 0.3, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 28\nNumber of Tank Car NARs for Gasoline by Cause*, U.S. and Canada: 2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,3),breaks = seq(0,3,1),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,1,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.2,size = 5)+
  geom_text(aes(label = per),nudge_y= 0.8,size = 5, color = "blue", fontface="bold.italic")
```

Exhibit 28
Number of Tank Car NARs for Gasoline by Cause*, U.S. and Canada: 2021

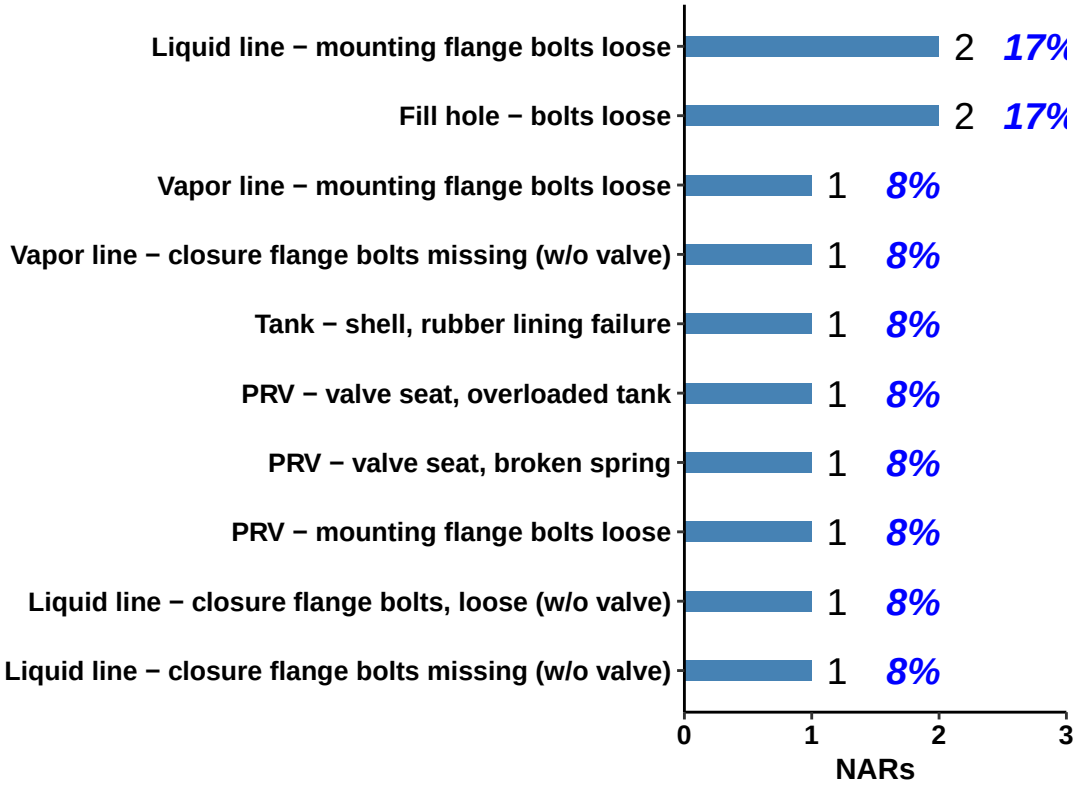



```
Exh_29_total = nrow(new14%>%
  filter(PSN == "Hydrochloric Acid" & `Cause Code` != 'NA'))

Exh_29 = Exh_14_raw%>%
  filter(PSN == "Hydrochloric Acid")%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_29_total,3))%>%
  arrange(desc(n))

Exh_29$per = scales::percent(Exh_29$per,1)
```

```
ggplot(data = Exh_29, aes(x = reorder(Exh_29$`Name for Exhibits`,n) ,y = Exh_29$n))+
  geom_bar(stat="identity", width = 0.3, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 29\nNumber of Tank Car NARs for Hydrochloric Acid by Cause*, U.S. and Canada: 2
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.15), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,3),breaks = seq(0,3,1),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
```

```
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(0,1,0,1,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.2,size = 5)+
  geom_text(aes(label = per),nudge_y= 0.8,size = 5, color = "blue", fontface="bold.italic")
```

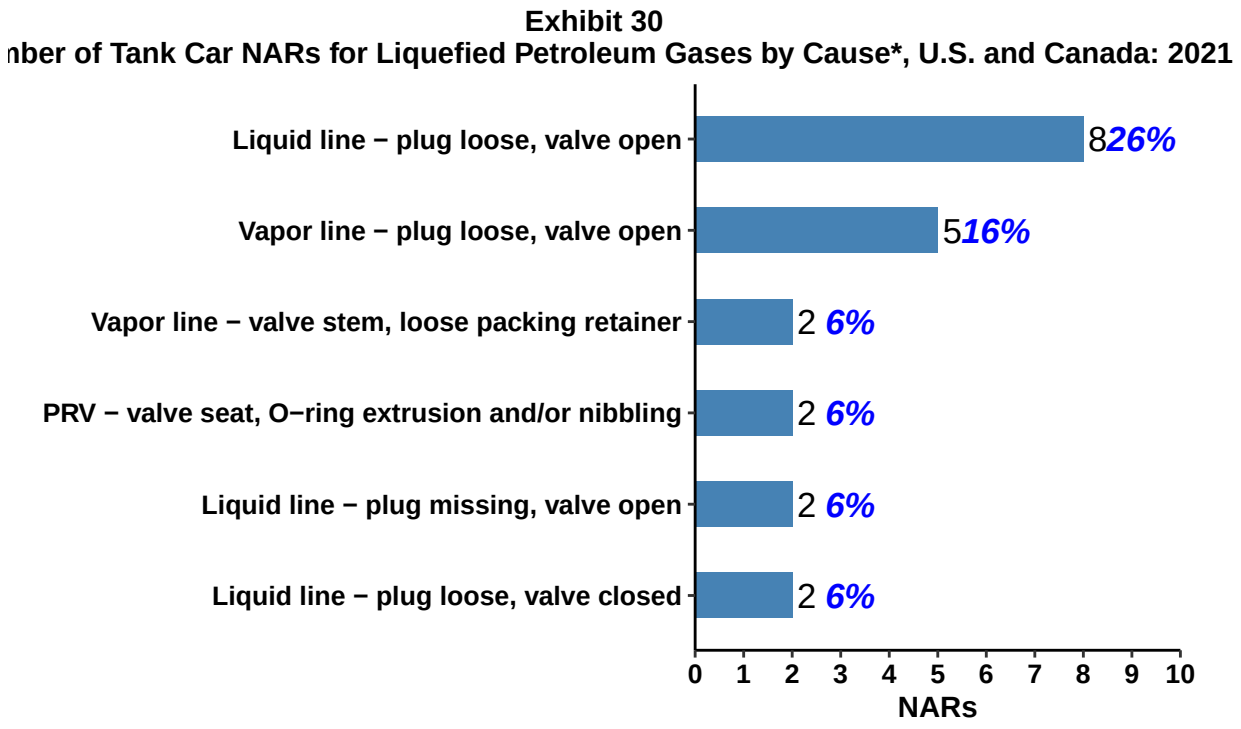
Exhibit 29
nber of Tank Car NARs for Hydrochloric Acid by Cause*, U.S. and Canada: 2




```
Exh_30_total = nrow(new14%>%
  filter(PSN == "LPG" & `Cause Code` != 'NA'))

Exh_30 = Exh_14_raw%>%
  filter(PSN == "LPG")%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_30_total,3))%>%
  arrange(desc(n))

Exh_30$per = scales::percent(Exh_30$per,1)

Exh_30_plot = Exh_30%>%
  filter(n>1)
```

```
ggplot(data = Exh_30_plot, aes(x = reorder(Exh_30_plot$`Name for Exhibits`,n) ,y = Exh_30_plot$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
```

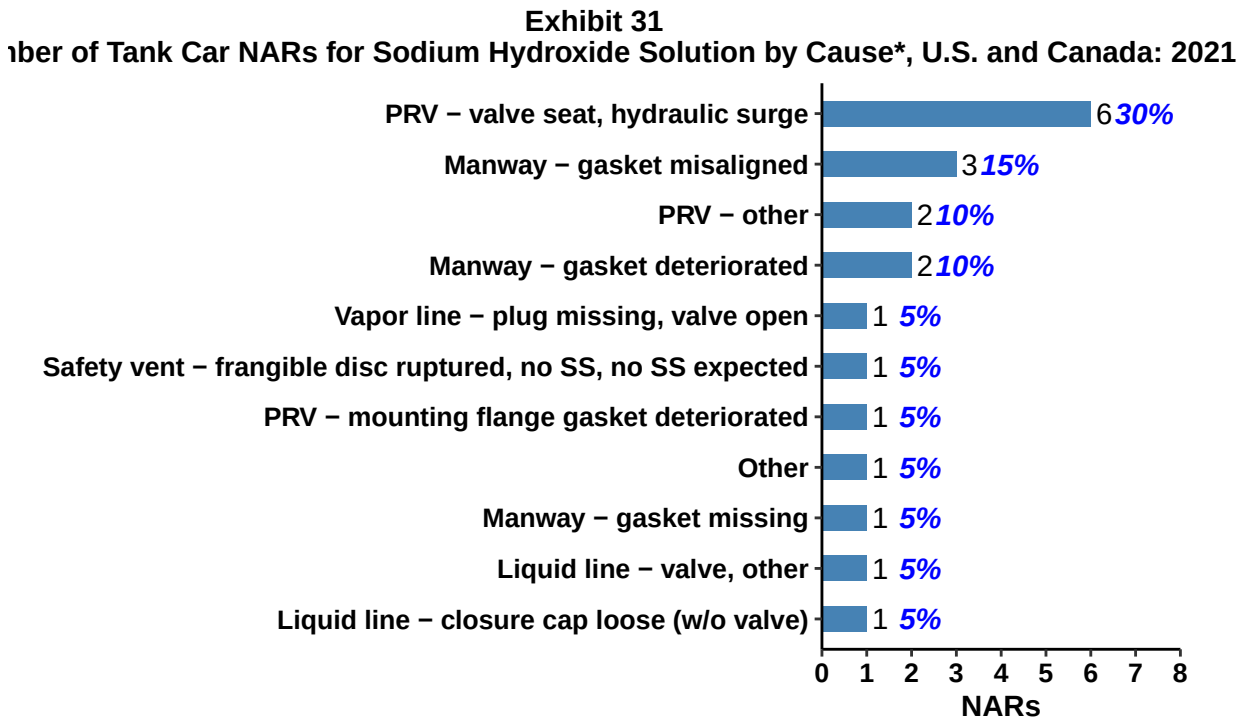
```
  labs(title = "Exhibit 30\nNumber of Tank Car NARs for Liquefied Petroleum Gases by Cause*, U.S. and Ca
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,10),breaks = seq(0,10,1),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(1,1,1,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.3,size = 4.5)+
  geom_text(aes(label = per),nudge_y= 1.2,size = 4.5, color = "blue", fontface="bold.italic")
```




```
Exh_31_total = nrow(new14%>%
  filter(PSN == "Sodium Hydroxide" & `Cause Code` != 'NA'))

Exh_31 = Exh_14_raw%>%
  filter(PSN == "Sodium Hydroxide")%>%
  group_by(`Name for Exhibits`)%>%
  count()%>%
  mutate(per = round(n/Exh_31_total,2))%>%
```

```
  arrange(desc(n))

Exh_31$per = scales::percent(Exh_31$per,1)
```

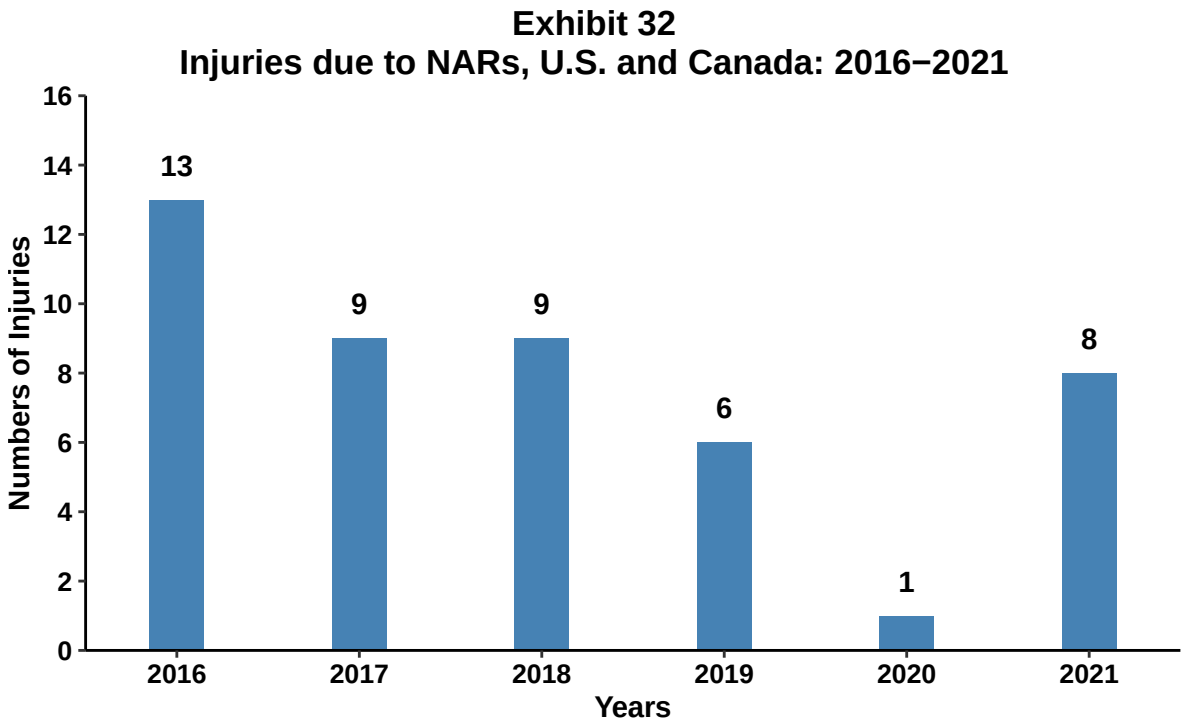
```
ggplot(data = Exh_31, aes(x = reorder(Exh_31$`Name for Exhibits`,n) ,y = Exh_31$n))+
  geom_bar(stat="identity", width = 0.5, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 31\nNumber of Tank Car NARs for Sodium Hydroxide Solution by Cause*, U.S. and Ca
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("NARs",limits = c(0,8),breaks = seq(0,8,1),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(1,1,1,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = n),nudge_y= 0.3,size = 4)+
  geom_text(aes(label = per),nudge_y= 1.2,size = 4, color = "blue", fontface="bold.italic")
```



```
#Exh_32_data = read_excel("Exhibit 31-34.xlsx", sheet = "2010-2018")
#Exh_32_data = Exh_32_data[,c(3,14,15,17,31,32,85,86,87,107,106)]
#colnames(Exh_32_data) = c("Railroad","PSN Group","Hazard Class","UN_NA","Cartype","Car_Spec (Stenciled
#library("writexl")
#write_xlsx(Exh_32_data,"Exh_32_data.xlsx")

Exh_injuries = df%>%
  filter(Injuries != 0 | Fatality != 0)%>%
  select("Railroad","PSN Group","Hazard Class","UN_NA","Cartype","Car_Spec (Stenciled Shipping Spec.)",
  mutate(Injuries = Injuries + Fatality)
Exh_injuries = Exh_injuries[,-11]

Injuries_year = data_frame(Year = rep(year,nrow(Exh_injuries)))
Exh_injuries = cbind(Exh_injuries,Injuries_year)

Exh_32_data = rbind(Exh_32_data,Exh_injuries)
```

```
Exh_32 = aggregate(Exh_32_data$Injuries, by = list(Year = Exh_32_data$Year), sum)
```

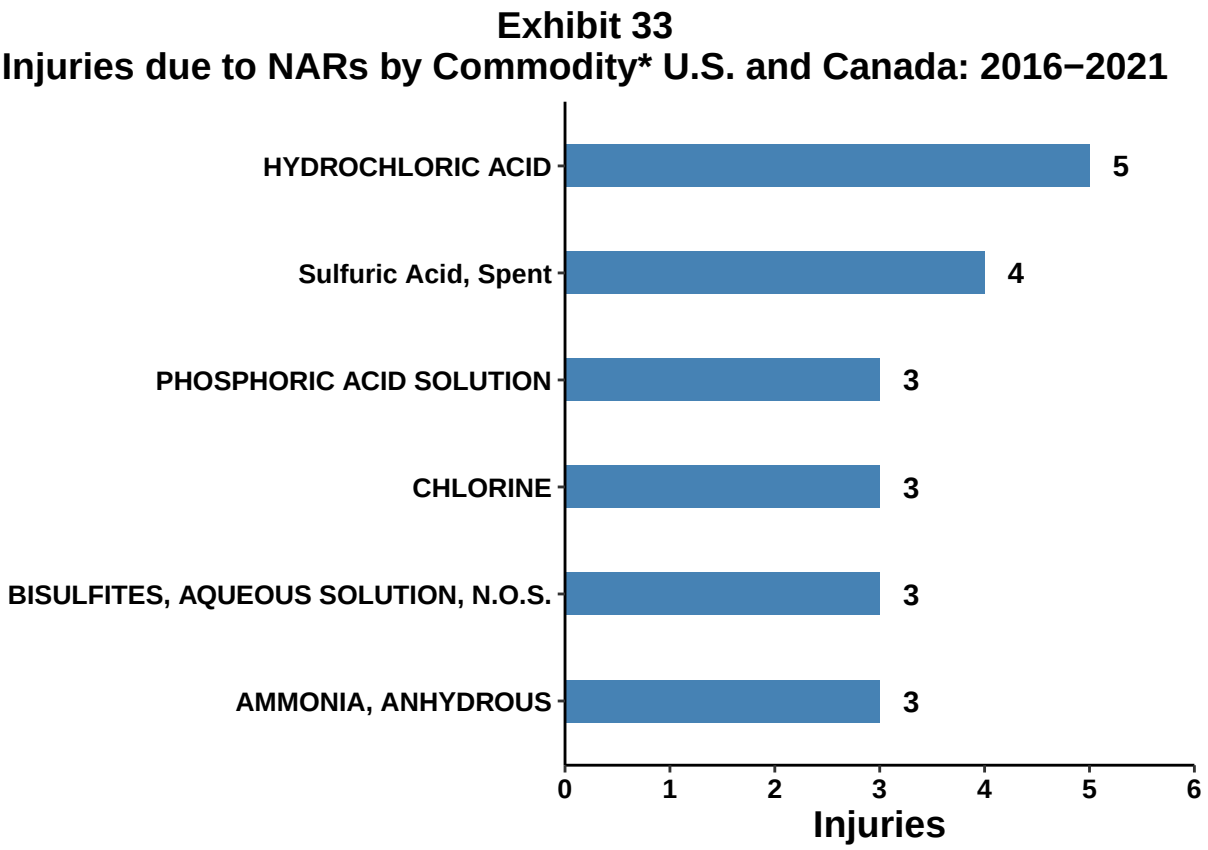
```
Exh_32_plot = Exh_32%>%
  filter(Year>year-6)

ggplot(data = Exh_32_plot, aes(x = Year, y = x))+
  geom_histogram(stat="identity", width = 0.3,fill = "#4682B4")+
  labs(title = "Exhibit 32\nInjuries due to NARs, U.S. and Canada: 2016-2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1), face = "bold"),
        axis.title.y = element_text(size = rel(1), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.2), face = "bold"))+
  scale_y_continuous("Numbers of Injuries",limits = c(0,16),breaks = seq(0,16,2),expand = c(0,0))+
  scale_x_continuous("Years",limits = c(year-5.5,year+0.5),breaks = seq(year-6,year+0.5,1),expand = c(0
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  theme(plot.margin = margin(1,1,1,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = x),nudge_y= 1,size = 4,fontface = "bold")
```




```
#Data prepared for Exh_33
Exh_33 = Exh_32_data%>%
  filter(Year >= 2016)
Exh_33 = aggregate(Exh_33$Injuries, by = list(Type = Exh_33$`PSN Group`), sum)
Exh_33 = arrange(Exh_33,desc(x))
```

```
Exh_33_plot = Exh_33%>%
  filter(x>2)

ggplot(data = Exh_33_plot, aes(x = reorder(Exh_33_plot$Type,x) ,y = Exh_33_plot$x))+
  geom_bar(stat="identity", width = 0.4, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 33\nInjuries due to NARs by Commodity* U.S. and Canada: 2016-2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
        axis.title.x = element_text(size = rel(1.3), face = "bold"),
        axis.title.y = element_text(size = rel(0.9), face = "bold"),
        legend.position = "none",
        plot.title = element_text(hjust = 0.5, size = rel(1.3), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("Injuries",limits = c(0,6),breaks = seq(0,6,1),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  #theme(plot.margin = margin(1,1,1,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
```

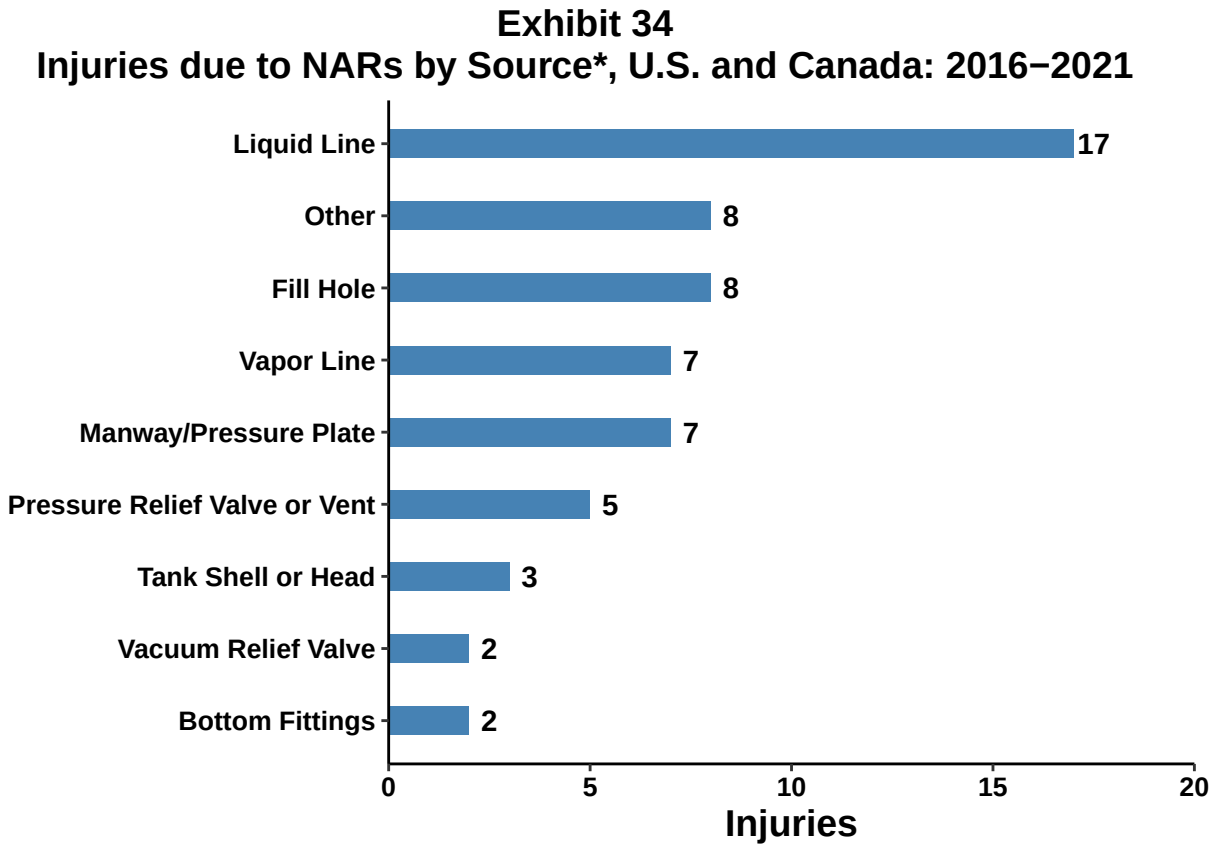
```
  geom_text(aes(label = x),nudge_y= 0.3,size = 4, fontface = "bold")
```




```
#Data prepared for Exh_34
code34_1 = Exh_32_data[,c(2,7,10,11)]
code34_2 = Exh_32_data[,c(2,8,10,11)]
code34_3 = Exh_32_data[,c(2,9,10,11)]
colnames(code34_1) = c("PSN","Cause Code","Injuries","Year")
colnames(code34_2) = c("PSN","Cause Code","Injuries","Year")
colnames(code34_3) = c("PSN","Cause Code","Injuries","Year")
code34 = rbind(code34_1,code34_2,code34_3)
Exh_34_data = merge(df_14,code34,"Cause Code")

#Output
Exh_34_raw = Exh_34_data%>%
  filter(Year >= 2015)

Exh_34 = aggregate(Exh_34_raw$Injuries, by = list(Type = Exh_34_raw$`Source (Exhibit 14 of the BOE Leak
Exh_34 = arrange(Exh_34,desc(x))
```

```
ggplot(data = Exh_34, aes(x = reorder(Exh_34$Type,x) ,y = Exh_34$x))+
  geom_bar(stat="identity", width = 0.4, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 34\nInjuries due to NARs by Source*, U.S. and Canada: 2016-2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
```

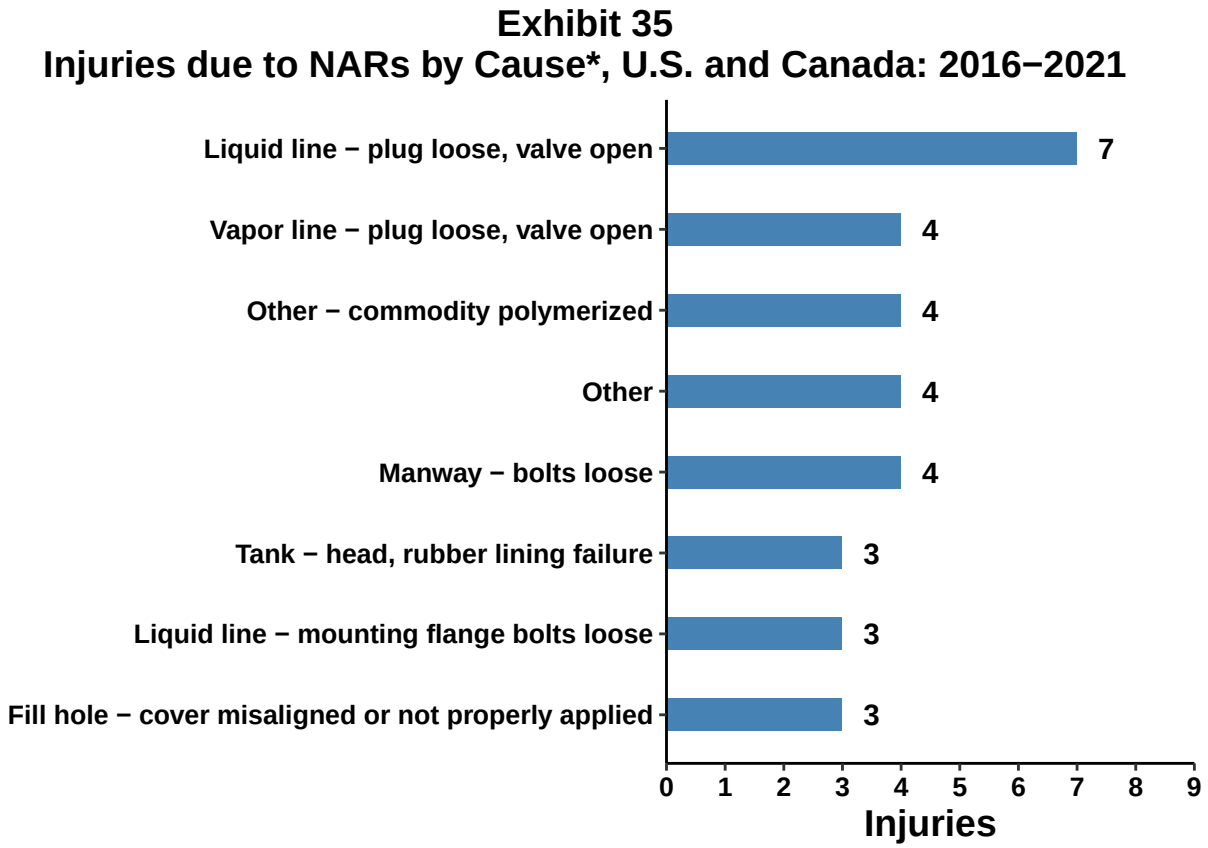
```
      axis.title.x = element_text(size = rel(1.3), face = "bold"),
      axis.title.y = element_text(size = rel(0.9), face = "bold"),
      legend.position = "none",
      plot.title = element_text(hjust = 0.5, size = rel(1.3), face = "bold"))+
  xlab(" ")+
  scale_y_continuous("Injuries",limits = c(0,20),breaks = seq(0,20,5),expand = c(0,0))+
  theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
  theme(axis.line = element_line())+
  theme(panel.border = element_blank())+
  #theme(plot.margin = margin(1,1,1,0,unit = "cm"))+
  theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
  geom_text(aes(label = x),nudge_y= 0.5,size = 4, fontface = "bold")
```




```
Exh_35 = aggregate(Exh_34_raw$Injuries, by = list(Type = Exh_34_raw$`Name for Exhibits`), sum)
Exh_35 = arrange(Exh_35,desc(x))
```

```
Exh_35_plot = Exh_35%>%
  filter(x>2)

ggplot(data = Exh_35_plot, aes(x = reorder(Exh_35_plot$Type,x) ,y = Exh_35_plot$x))+
  geom_bar(stat="identity", width = 0.4, fill = "#4682B4")+
  coord_flip()+
  labs(title = "Exhibit 35\nInjuries due to NARs by Cause*, U.S. and Canada: 2016-2021")+
  theme_bw()+
  theme(plot.title.position = "plot",
```

```
      axis.title.x = element_text(size = rel(1.3), face = "bold"),
      axis.title.y = element_text(size = rel(0.9), face = "bold"),
      legend.position = "none",
      plot.title = element_text(hjust = 0.5, size = rel(1.3), face = "bold"))+
xlab(" ")+
scale_y_continuous("Injuries",limits = c(0,9),breaks = seq(0,9,1),expand = c(0,0))+
theme(panel.grid.major =element_blank(), panel.grid.minor = element_blank())+
theme(axis.line = element_line())+
theme(panel.border = element_blank())+
#theme(plot.margin = margin(1,1,1,0,unit = "cm"))+
theme(axis.text = element_text(size = rel(0.9), face = "bold", colour = "black"))+
geom_text(aes(label = x),nudge_y= 0.5,size = 4, fontface = "bold")
```




```
#sheets = list("Exh_11" = Exh_11, "Exh_12" = Exh_12, "Exh_13" = Exh_13, "Exh_14" = Exh_14, "Exh_15" = E
#write_xlsx(sheets,"NAR_report_2022_Exh11_35.xlsx")
```