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RADIATION AND THREE MILE ISLAND

NOTES

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## RADIATION

### WHAT IS IT?

RADIATION IS ENERGY--SIMILAR TO LIGHT IN SOME RESPECTS,  
BUT DIFFERENT IN IMPORTANT WAYS

### WHERE DOES IT COME FROM?

RADIATION IS EMITTED FROM MANY SOURCES:

- SUN
- ELECTRONIC DEVICES
- RADIOACTIVE MATERIALS (SOME NATURALLY-OCCURRING)

### WHERE DOES IT GO?

RADIATION IS ABSORBED IN SUBSTANCES THROUGH WHICH IT  
PASSES:

- AIR
- STRUCTURAL MATERIALS
- BIOLOGICAL MATERIAL--LIVING TISSUE

## RADIATION PROTECTION

### EXTERNAL RADIATION SOURCES

- REDUCE TIME OF EXPOSURE
- INCREASE DISTANCE FROM SOURCE
- PLACE SHIELDING MATERIAL BETWEEN SOURCE AND PERSON

### INTERNAL RADIATION SOURCES

- LIMIT ENTRY INTO BODY BY ISOLATING PERSON FROM AIR, FOOD, OR WATER CONTAINING THE RADIOACTIVE MATERIAL, OR BY REMOVING RADIOACTIVE MATERIAL FROM AIR, FOOD AND WATER
- ADMINISTER DRUGS TO SPEED UP NATURAL REMOVAL OF RADIOACTIVITY FROM THE BODY

## RADIOACTIVE MATERIAL

RADIOACTIVE MATERIAL IS JUST LIKE OTHER MATERIAL, BUT IT SPONTANEOUSLY AND GRADUALLY TRANSFORMS TO A DIFFERENT KIND OF MATERIAL, EMITTING RADIATION IN THE PROCESS.

### RELATED TERMS:

- ISOTOPE - TYPE OF MATERIAL
- DECAY - THE PROCESS OF TRANSFORMING FROM ONE ISOTOPE TO ANOTHER
- HALF-LIFE - THE TIME REQUIRED FOR HALF OF ANY QUANTITY OF ISOTOPE TO TRANSFORM. CAN RANGE FROM VERY SHORT (SECONDS) TO VERY LONG (BILLIONS OF YEARS).
- ACTIVITY - TRANSFORMATION RATE OR NUMBER OF TRANSFORMATIONS PER SECOND EXPRESSED IN THE SPECIAL UNIT OF MEASURE CALLED THE "CURIE." USED TO EXPRESS BOTH THE AMOUNT OF RADIOACTIVE MATERIAL PRESENT, AND THE RATE OF EMISSION OF RADIATION.

## RADIATION EMISSION

EACH ISOTOPE EMITS ITS OWN MIX OF RADIATION TYPES. THE TWO TYPES OF INTEREST HERE DIFFER IN ABSORPTION CHARACTERISTICS.

### BETA

- NOT HIGHLY PENETRATING--STOPPED BY ABOUT 10 METERS OF AIR OR A FEW MILLIMETERS OF TISSUE
- EXTERNAL SOURCES IRRADIATE ONLY THE SKIN

### GAMMA

- HIGHLY PENETRATING--ONLY SMALL FRACTION ABSORBED DURING PASSAGE THROUGH BODY
- ALL TISSUES IRRADIATED UNIFORMLY
- HEAVY MATERIALS REQUIRED FOR SHIELDING

## RADIATION ABSORPTION

THE HAZARDS OF RADIATION ARE RELATED TO ABSORPTION OF RADIATION IN LIVING TISSUE.

### RELATED TERMS:

- DOSE RATE - THE RATE OF ABSORPTION OF RADIATION WITH A SPECIAL UNIT OF MEASURE, "MILLIREM PER HOUR."
  
- DOSE - THE TOTAL AMOUNT OF RADIATION ABSORBED WITH A SPECIAL UNIT OF MEASURE, "MILLIREM".

DOSE IS THE BOTTOM LINE OF RADIATION HAZARD EVALUATION.

THE LOWER THE DOSE, THE LOWER THE HAZARD.

DOSE RATE IS NOT SUFFICIENT FOR EVALUATING RADIATION HAZARD.

DOSE FROM MULTIPLE SOURCES OF RADIATION

EACH OF US IS EXPOSED TO MANY RADIATION SOURCES:

- RADIATION FROM THE SUN
- RADIATION FROM RADIOACTIVE MATERIALS WHICH OCCUR NATURALLY IN SOIL
- RADIATION FROM RADIOACTIVE MATERIALS WHICH OCCUR NATURALLY AND ENTER OUR BODY IN FOOD, WATER OR AIR
- RADIATION FROM MEDICAL AND DENTAL TREATMENT
- RADIATION FROM RADIOACTIVE MATERIALS RELEASED TO AIR AND WATER FROM NORMAL OPERATIONS OF NUCLEAR POWER PLANTS
- RADIATION FROM ELECTRONIC PRODUCTS SUCH AS TELEVISION SETS

RADIATION HAZARD DEPENDS UPON THE TOTAL DOSE FROM ALL OF THESE SOURCES.

RADIOLOGICAL IMPACT OF TMI ACCIDENT

SOURCES OF DATA

- ④ EMERGENCY MOBILE RADIATION MONITORING TEAMS
- ④ ENVIRONMENTAL MONITORING PROGRAM
- ④ TLD MEASUREMENTS
- ④ METEOROLOGICAL TOWER
- ④ STACK VENT SAMPLES



DETERMINATION OF RADIATION EXPOSURE

- USE MEASURED ACCUMULATED DOSES DIRECTLY FROM TLD'S
- COMPUTE DILUTION OF RELEASED GASES USING ATMOSPHERIC DISPERSION MODEL AND METEOROLOGICAL DATA. WE KNOW THAT:
  - HIGHER WIND SPEED REDUCES DOSES
  - WIND DIRECTION TELLS WHERE PLUME GOES
  - VERTICAL TEMPERATURE DIFFERENCE DEFINES TURBULENCE
  - RADIOACTIVE MATERIAL IN PLUMES CANNOT RECONCENTRATE
- USE RADIATION MONITORS INSIDE PLANT BUILDINGS TO DETERMINE WHEN RELEASES OCCURRED
- WIND WAS BLOWING TOWARD TLD'S DURING MAJOR RELEASES
- COMPUTE RADIATION DOSES AT ALL LOCATIONS AROUND THE PLANT

RESULTS FROM ASSESSMENT

- LESS THAN <sup>13</sup>10 MILLION CURIES OF NOBLE GAS WERE RELEASED
- MAXIMUM WHOLE BODY DOSE FROM GAMMA RADIATION WAS ABOUT 76 MILLIREM <sup>486</sup>
- MAXIMUM BETA DOSE TO THE SKIN WAS ABOUT 125 MILLIREM
- DOSES ARE CONSISTENT WITH THOSE CALCULATED BY OTHERS
- RELEASE OF ABOUT 14 CURIES OF IODINE WAS MEASURED FROM THE PLANT VENT
- DOSE TO THE THYROID GLAND DUE TO INHALATION OF IODINE IS LESS THAN 10 MILLIREM
- LESS THAN ONE-ONE THOUSANDTH OF A CURIE OF PARTICULATES WERE RELEASED AND DOSES WERE EXTREMELY SMALL

WHY IS CONTROLLED VENTING OF KRYPTON NECESSARY

- ALL RADIOACTIVE GASES IN REACTOR BUILDING HAVE DECAYED EXCEPT KR-85
- THE HALF-LIFE OF KR-85 IS ABOUT 10 YEARS THUS IT WILL NOT SOON DECAY
- THE REMAINING KR-85 CONSTITUTES LESS THAN ONE-ONE THOUSANDTH OF THE ORIGINAL NOBLE GASES IN THE BUILDING
- KR-85 MUST BE REMOVED SO THAT RECOVERY EFFORT CAN PROCEED
- STUDIES HAVE BEEN MADE WHICH SHOW THAT CONTROLLED VENTING OF KR-85 CAN BE ACCOMPLISHED WITH VERY LITTLE INCREASE IN OFFSITE DOSE

PROCEDURE FOR CONTROLLED VENTING

- THE AMOUNT OF KR-85 INSIDE THE REACTOR BUILDING IS WELL-KNOWN FROM SAMPLES
- VENTING SYSTEM WILL METER RELEASE AT RATES UP TO 1,000 CUBIC FEET PER MINUTE
- ONLY A SMALL FRACTION OF THE 2 MILLION CUBIC FOOT BUILDING VOLUME WOULD BE RELEASED EACH HOUR
- VENTING WOULD ONLY TAKE PLACE DURING WEATHER CONDITIONS WHICH RESULT IN LOW DOSE RATES
- ONE TO TWO MONTHS WILL BE REQUIRED TO SLOWLY RELEASE GASES
- RELEASES WILL BE FILTERED AND MONITORED BY TWO RADIATION SENSORS
- A COMPUTER CONNECTED TO THE WEATHER TOWER WILL AID OPERATORS IN CHOSING THE BEST TIME FOR RELEASES TO MINIMIZE DOSES
- RADIATION MONITORS AROUND THE PLANT WILL BE USED TO CONFIRM LOW DOSES ARE MAINTAINED

RADIATION DOSES DUE TO CONTROLLED VENTING

USING HISTORICAL WEATHER DATA AND THE PROPOSED PROCEDURE FOR CONTROLLED VENTING, THE FOLLOWING DOSES WERE CALCULATED:

- MAXIMUM OFFSITE WHOLE BODY GAMMA DOSE WOULD BE ONE-TENTH OF A MILLIREM
  
- MAXIMUM OFFSITE SKIN DOSE WOULD BE 5 MILLIREM

A COMPARISON WITH NRC DOSE OBJECTIVES FOR OPERATING NUCLEAR POWER PLANTS SHOWS:

- WHOLE BODY DOSE IS 50 TIMES LOWER THAN THE 5 MILLIREM DOSE OBJECTIVE
  
- SKIN DOSE IS 3 TIMES LOWER THAN THE 15 MILLIREM DOSE OBJECTIVE

RISK DUE TO ALTERNATIVES TO VENTING

ALTERNATIVES INCLUDE:

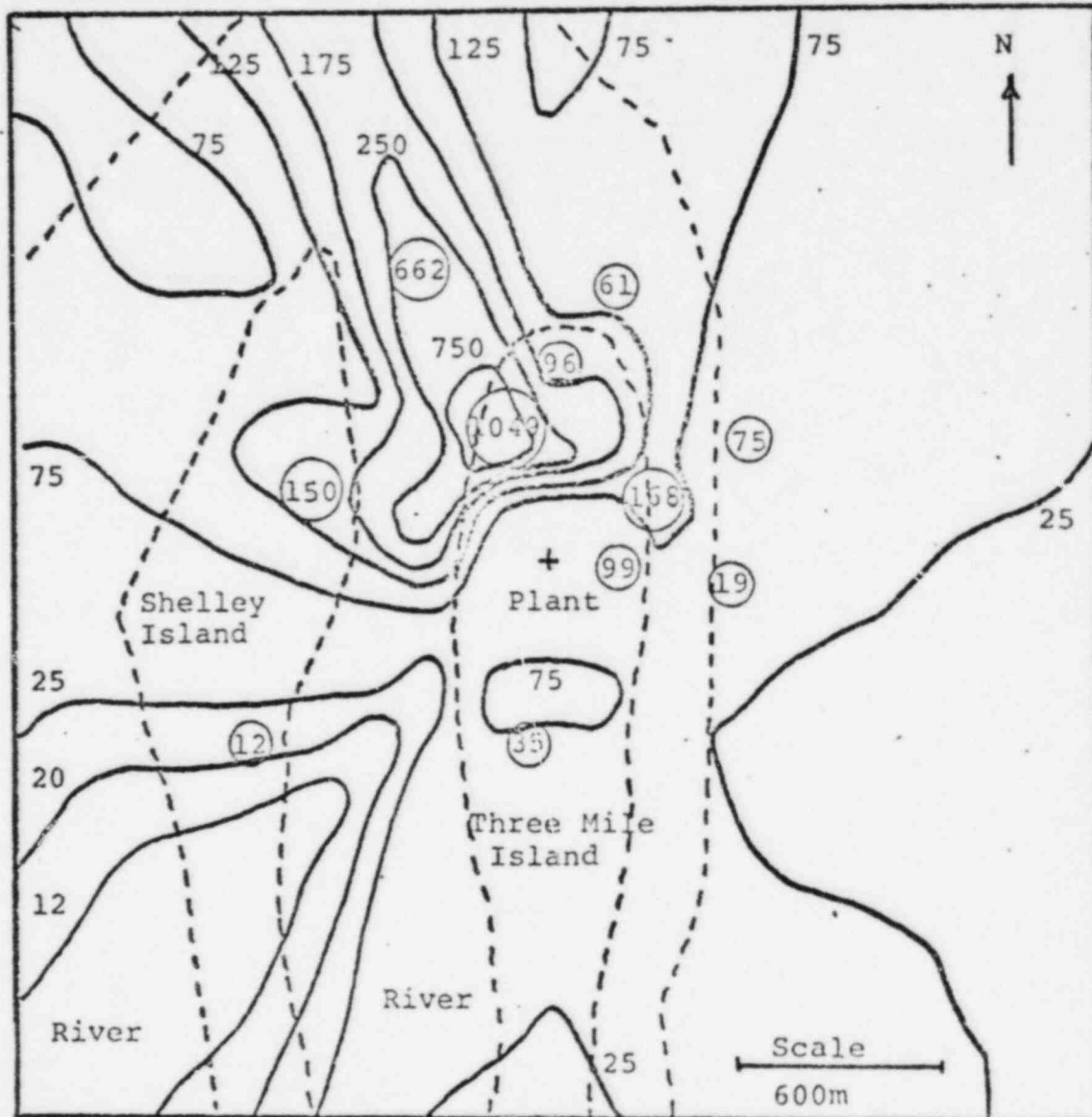
- CRYOGENICALLY REMOVING KRYPTON BY COOLING GASES TO EXTREMELY COLD TEMPERATURES AND STORING IT ONSITE
- COMPRESSING AND STORING THE KRYPTON LADEN REACTOR BUILDING AIR AND STORING IT ONSITE
- POTENTIAL FOR FAILURE OF STORAGE SYSTEMS EXISTS
- DOSES DUE TO FAILURE COULD RESULT IN WHOLE BODY DOSES AS HIGH AS 49 MILLIREM AND BETA SKIN DOSES AS HIGH AS 4090 MILLIREM

Table  
Radiation Exposure in Perspective

<u>Source</u>	<u>Whole Body Dose (millirem)</u>
Annual natural background in Denver, Colorado	193
Annual natural background in Harrisburg, PA	116
Highest offsite dose due to TMI accident	76
Average annual medical exposure	40
Highest dose in this location	50
Additional dose due to controlled venting	0.1 (one tenth of of a millirem)

Figure 1

Estimated Whole Body Dose (millirem)  
Within a One Mile Radius\*  
(Period of Record 3/28-4/6)\*\*



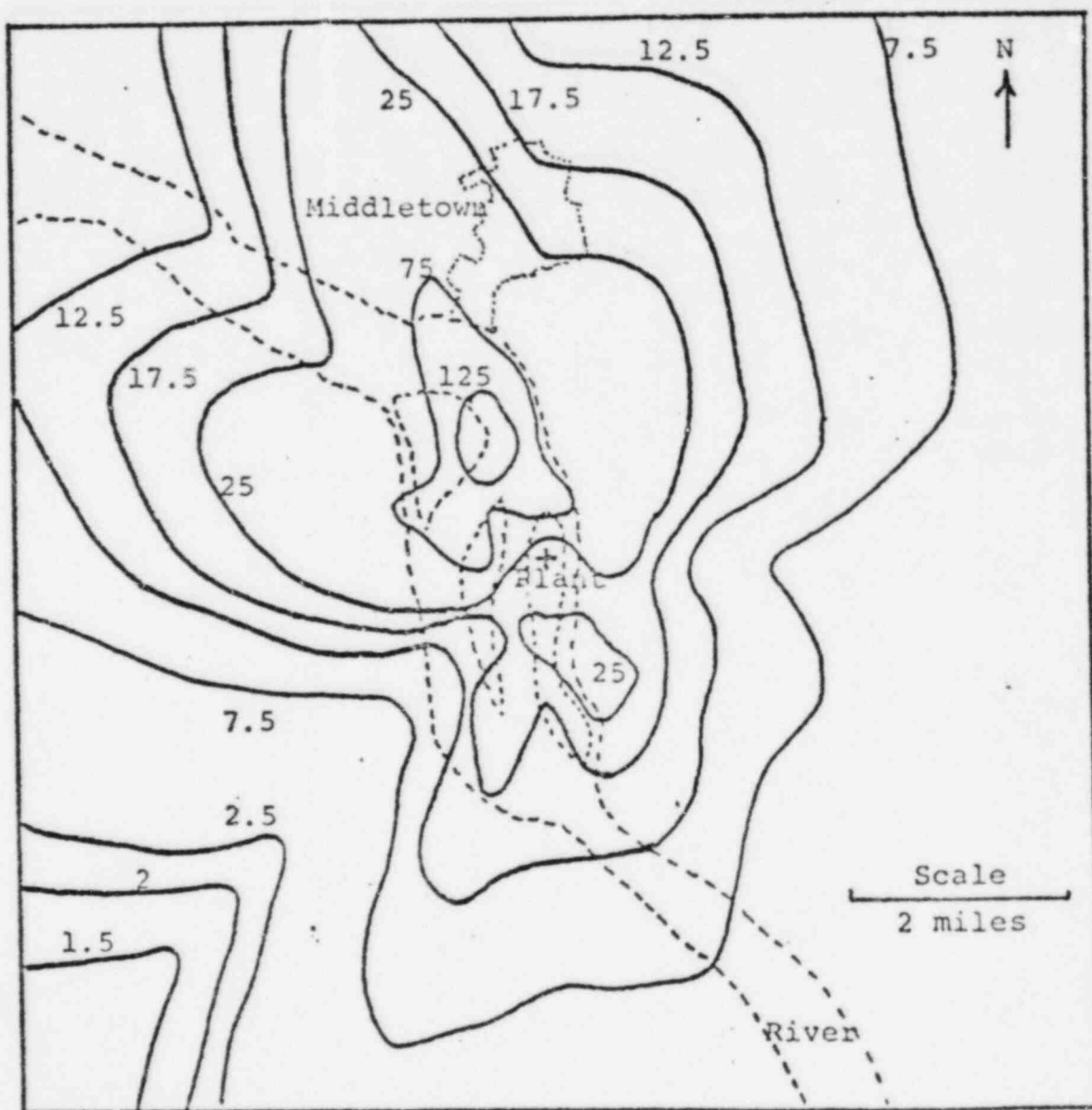
\*Measured TLD doses over the same time period given in circles for comparison

\*\*Dose is the total dose from all activity due to the accident which was released through April 6. This is more than 99% of all such activity released through April 30.



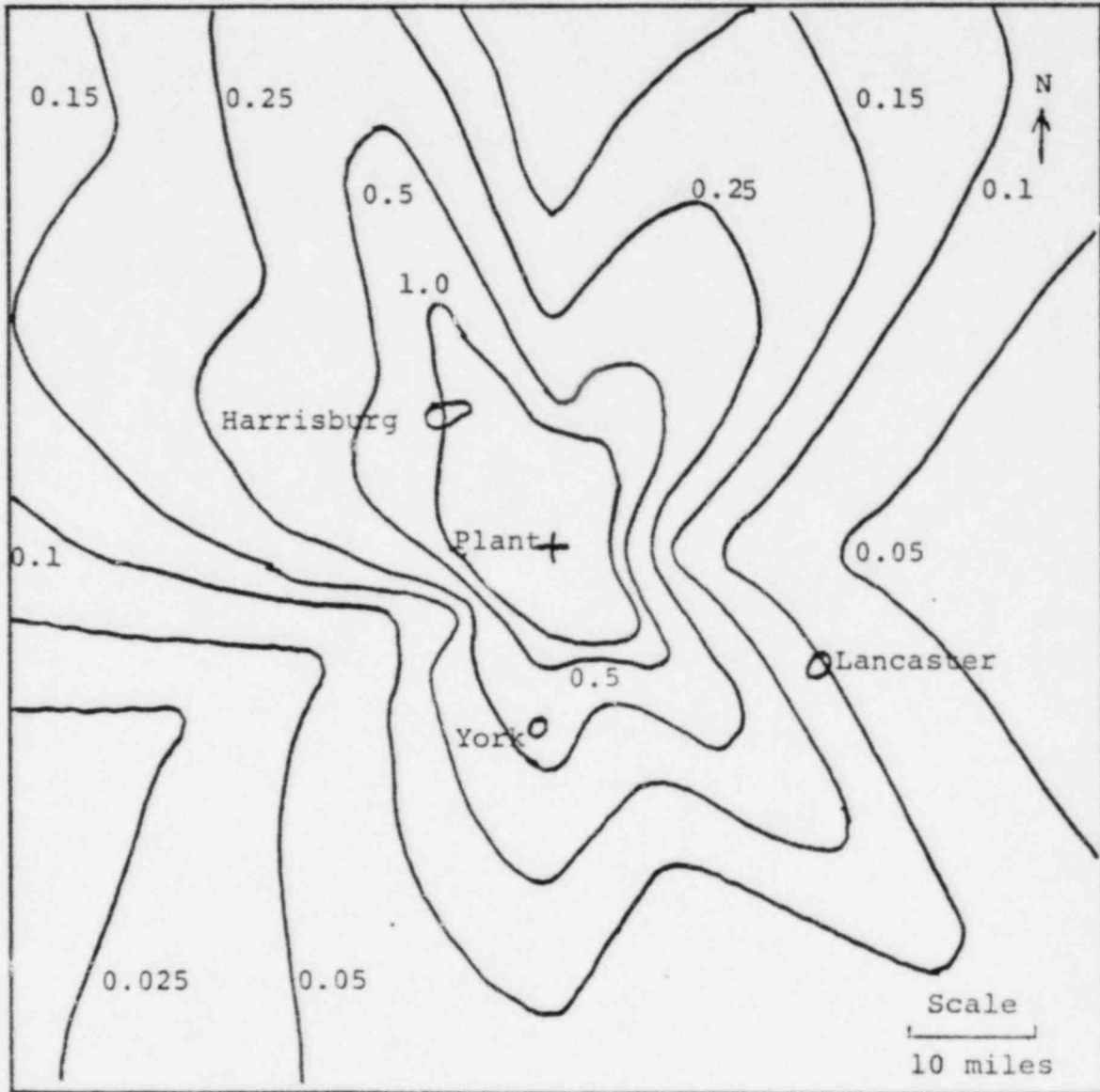
Figure 2

Estimated Whole Body Dose (millirem)  
Within a Five Mile Radius  
(Period of Record 3/28-4/6)\*



\*Dose is the total dose from all activity due to the accident which was released through April 6. This is more than 99% of all such activity released through April 30.

Figure 3  
Estimated Whole Body Dose (millirem)  
Within a 50 Mile Radius  
(Period of Record 3/28-4/6)\*



\*Dose is the total dose from all activity due to the accident which was released through April 6. This is more than 99% of all such activity released through April 30.