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SCHWENCER,A.	Licensing Branch 2

SUBJECT: Submits response to License Condition 2.(13) re gas pipeline.One oversize drawing encl.Aperture card is available in PDR.

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DRWGS. to PM

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[illegible]

PP&L Pennsylvania Power & Light Company
Two North Ninth Street • Allentown, PA 18101 • 215 / 770-5151

Norman W. Curtis
Vice President-Engineering & Construction-Nuclear
215 / 770-5381

September 9, 1982

Mr. A. Schwencer, Chief
Licensing Branch No. 2
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
NEW INFORMATION ON GAS PIPELINE
ER 100450 FILE 841-2
PLA-1284

Docket No. 50-387

Dear Mr. Schwencer:

This letter and its attachments provide our response to condition 2.(13) of License No. NPF-14 and in our opinion resolves the issue.

In discussions with the Pennsylvania Gas & Water Company (PG&W) aimed at developing administrative controls referenced in condition 2.(13) (b), Pennsylvania Power & Light Company (PP&L) realized that the 2" orifice run previously referenced by PG&W would not be capable of limiting potential total break flow to 39 m^3/sec. as originally anticipated. These 2" orifices are used chiefly for metering purposes and as such cannot survive significant differential pressure. In addition, PP&L learned that PG&W desired to change the 2" orifices to 2.5" in the next few months to improve their metering accuracy.

As a result of these developments, PP&L enlisted the services of Mr. James H. Stannard (see Attachment 1) to perform a complete study of the PG&W Shickshinny City Gate Station configuration and operation.

Attachment 2 to this letter is Mr. Stannard's assessment of our situation. Basically, he recommends modifications to the flow regulators in the Shickshinny City Gate Station to provide the flow restrictions previously discussed, limiting the flow from the station to Berwick to a maximum of 30 m^3/sec. under design (1200 psig) flow conditions. Furthermore, he recommends the future installation of a check valve to eliminate the 9 m^3/sec. backflow from Berwick, whereupon the Shickshinny City Gate Station flow regulators could be restored to their original conditions to meet increased flow needs of PG&W, while still meeting the 39 m^3/sec. total flow previously established.

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Drawings To: PM

PP&L is in the process of finalizing agreements with PG&W that the flow regulator restoration could not occur until the check valve is installed. We will also reaffirm with PG&W that PP&L must be consulted on any system configuration change that could affect the safe operation of Susquehanna SES.

PP&L would like confirmation from the staff that the information presented in this letter meets the intent of License Condition 2.(13). Parts (a), (c) and (d) should be satisfied in that we will commit to provide the recommended changes to the flow regulators in the Stannard report attached (resulting in a more reliable flow restriction) by December 31, 1982. PP&L will also commit to ensuring that a check valve to eliminate backflow from Berwick will be installed before any subsequent changes are made to the regulators. Part (b) is no longer necessary in that both lines being simultaneously open will not impact the established total flow limitations.

Given the fact that the present design of the gate station would require at least three failures (two equipment failures or human errors in addition to a pipeline rupture) to achieve flows greater than 39 m^3/sec., PP&L believes that the commitments outlined above are more than sufficient to ensure the safe operation of Susquehanna SES.

Upon receipt of staff approval, PP&L will direct PG&W to proceed with the installation of the flow regulator modifications, and provide the above mentioned agreements for review as soon as they are finalized.

Very truly yours,

N W Curtis

N. W. Curtis
Vice President - Engineering & Construction - Nuclear

RRS:mcb

Attachments
cc: Mr. R. L. Perch - NRC

James H. Stannard, Jr.

Education: Stanford University
B.S. Mechanical Engineering 1951

Experience: Gas Engineer, Pacific Gas & Electric Co.
San Francisco, Calif. 1951 - 1961

Supervisory design of major natural gas measurement and control facilities, including production, transmission, distribution and storage projects. Responsibilities included instrumentation, remote and supervisory control and large diameter piping design.

Consulting Engineer (owner) Stannard & Co. 1961 - present.

Engineering design, technical and economic feasibility studies, preparation of specifications, bid analysis and construction supervision.

Projects have included liquefied natural gas, natural gas measurement and compression, total energy projects, storm water and sewage pumping systems, food preparation, a propane gas distribution system, and nuclear containment design review.

Clients have included:

Southern California Gas Co. *
San Diego Gas & Electric Co. *
Northwest Natural Gas Co. *
Buttes Gas & Oil Co.
Santa Fe Drilling Co.
County of Marin (California)
Cryodry Corp.
Nevada Power Co.
Vangas Corp.
Citizens Gas & Coke Utility *
UGI Corp. *
Elizabethtown Gas Co. *
Consolidated Edison Co. of N.Y. *
Southern Connecticut Gas Co. *
Connecticut Natural Gas Co. *
Fall River Gas Co. *
Distrigas Corp. *
New England Electric System *
Pacific Gas & Electric Co. *
Navajo Tribal Utility Authority *
Intermountain Gas Co. *
American Electric Power Service Corp.

* Work for these clients has been in connection with Liquefied Natural Gas.

Professional Associations:

American Society Of Mechanical Engineers
National Fire Protection Association
(member of Liquefied Natural Gas Committee)

Registration:

Registered or Licensed Professional Engineer

- California
- Nevada
- Oregon
- Idaho
- Wyoming
- Indiana
- Pennsylvania
- New Jersey
- New York
- Connecticut
- Massachusetts
- Arizona
- Minnesota

STANNARD & COMPANY
ENGINEERS
P.O. BOX 175, BASKING RIDGE, NJ 07920 (201) 766-7300

September 7, 1982

Mr. Robert J. Shovlin
Assistant Project Director - Susquehanna
Pennsylvania Power & Light Company
Two North Ninth Street
Allentown, PA 18101

Dear Mr. Shovlin:

At your request, I have visited the Shickshinny City Gate Station of the Pennsylvania Gas and Water Company (PG&W) which is in the vicinity of your Susquehanna Steam Electric Station. In addition, I have traveled the entire route (approximately 9 miles) of the 12" natural gas pipeline which has been constructed from that Gate Station to a point in the Berwick gas distribution system, after running adjacent to your Susquehanna plant. I have also had an opportunity to discuss both the design and operation of the Gate Station with Messrs. Gerald B. Taylor, Robert B. Walsh and Allan Lyle from PG&W. Also present at that meeting were Messrs. Donald J. Kohn, A. William Metzger and R. R. Sgarro from PP&L.

The Schickshinny City Gate Station is located approximately 1500 feet west of U.S. Highway 11 and about one mile north of Road T419, which is contiguous with the northerly property line of your Steam Electric Station. The 12" pipeline follows Highway 11 to Road T419 and is then within the right of way of that road for a considerable distance to the west past the Susquehanna Station. The pipeline distance from the Gate Station to the area of concern (as indicated in Figure 2 of the attachments to the letter of June 1, 1982 from Mr. Norman W. Curtis to Mr. A. Schwencer) is 8700 feet. The pipeline has an internal diameter of 12.188 inches, a wall thickness of 0.281 inches (9/32") and operates at pressures below 380 psig. The pipeline was constructed, inspected and tested in accordance with 49CFR Part 192. It is less than one year old, is cathodically protected against corrosion and has five feet of cover in the vicinity of the Steam Electric Station.

Pennsylvania Gas and Water Company has provided both schematic and design drawings of the Shickshinny City Gate Station (Drawings BER-4106-65 and BER-4094-65, 12 sheets), manufacturer's literature and capacity tables for the regulating valves and a narrative description of the station's operation. Referring to Drawing BER-4106-65, which is a simplified "Schematic Flow Diagram" of the Gate Station, it can be seen that the high pressure (700 - 1200 psig) natural gas first passes through one or two (the automatic shut-off valve on one run is not shown) orifice meters, then through a remotely controlled valve and finally through parallel regulating valves which drop the pressure and/or control the flow of gas into the 12" pipeline to Berwick. Not shown on this simplified drawing are the heater, the fuel supply to the heater, future connections and the station by-pass, all of which are shown on the various sheets of Drawing BER-4094-65.

The normal differential pressure across the orifice meter plates is less than 100 inches of water (approximately 4 psi) and the design of the orifice fitting is such to accomodate only moderate differential pressures. The use of an orifice, designed for measurement purposes, as a flow restrictor would probably result in the orifice plate (normally 1/8" thick) dishing, coming free and lodging in some downstream restriction such as a valve or elbow. The sole purposes of these orifice meters are for custody transfer measurement (TRANSCO to PG&W), telemeter signal to Wilkes-Barre and a signal input to the flow controller.

After leaving the orifice meters, the gas passes through a gas fired heater (which is not shown on the schematic drawing). The function of this heater is to preheat the gas stream prior to regulation inorder to overcome the Joule-Thomson cooling that occurs across the regulators. (Since there is no work done, the expansion is isenthalpic and the ΔT is approximately one degree Fahrenheit per atmosphere of pressure drop.) There are two reasons to avoid the low temperatures that would result if the gas were not heated. The first is to avoid the freezing of the ground and the potential frost heave that could occur immediately downstream of the station. The second reason for the heater is to prevent the formation of hydrates which could plug the pipeline. (Hydrates are complex unstable compounds which can form when liquid water is present in natural gas at high pressures and low temperatures.) Failure of the heater could produce *severe operating problems* for the Gas Company but *would not have any safety related impact* upon the Susquehanna Steam Electric Station.

Sheets 1 and 8 of Drawing BER-4094-65 indicate a station by-pass. It should be noted that a "blind spool-piece" has been incorporated in this by-pass. This "blind spool-piece" eliminates any possibility of maloperation by merely opening a valve. (The spool-piece is a length of 4" pipe with blind flanges welded to each end.) Operation of this by-pass requires the physical installation of both regulators and relief valves (see note on sheet 8).

The heated gas then passes through a 12" x 10" ball valve which can be remotely operated by the PG&W dispatcher in Wilkes-Barre. While there is a reduction of area (approximately 30%) in the throat of this valve, it provides an almost insignificant flow restriction when wide open. The control system for this valve provides for no change of position in the event of communication and/or power failure and fail-open in the event of a local control system failure. At the present time, there is no automatic operation of this valve. The Gas Company dispatchers consider continuity of service as a first priority. (The gas industry generally equates continuity of service with safety.) Thus, lacking specific information, most gas dispatchers would be reluctant to close the remote valve, even with telemetered information indicating a major leak or line break. Therefore, this remotely operated valve should be considered as only a secondary back-up, not a primary safeguard as it relates to the Susquehanna Steam Electric Station.

The pressure and/or flow regulating equipment downstream of the remotely operated valve, provide a number of functions (See PG&W Drawing BER-4094-65). The regulating valves (B, C, D and E) and relief valve (F) are all of the same type, *i.e.* Grove Flexflo. The Grove Flexflo valve consists of an expansible rubber-like tube over a slotted core with an internal septum. When the valve is closed, the pressure on the outside of the tube equals the upstream pressure. If a pressure differential exists across the valve, the higher upstream (and outside) pressure squeezes the tube against the slotted downstream portion of the core, closing off the valve. The soft tube provides a "bubble-tight" shut-off which is particularly important in the relief valve application. "Bleeding-off" the pressure around the tube, allows the tube to inflate - opening the valve. Control of the tube pressure is accomplished with external pilots or control valves (G through M).

The two runs of the regulating portion of the Gate Station have totally different functions. The right hand run (regulators C and E) is the primary side. Regulator E is a flow control valve and its tube pressure is controlled by a small diaphragm operated valve (L) and inturn an electro-pneumatic converter (Z). The electronic signal is generated by an electronic flow controller, which may be over-ridden by an electronic pressure controller. The "set-point" of the flow controller may be adjusted remotely from Wilkes-Barre. This adjustment may vary both hourly and seasonally, but at the present time is always below 2.5M^2 scf/hr. (20 m^3/sec.). If the set-point exceeds the gas supply needs of the pipeline, the pressure will rise in the pipeline until the pressure controller over-rides the flow controller - thus reducing the flow.

Regulator C has a dual function. Normally pilot I controls valve C to maintain an intermediate pressure (P_2) of 600 psig. If a failure occurs in regulator E, causing it to fail open, pilot J would then control regulator C to prevent the downstream pressure from exceeding 380 psig.

The left hand leg is solely a pressure control system. Regulator D and its associated pilot K remain closed unless the downstream pressure falls below the set-point of K, which is presently set at 100 psig. This pressure would normally be inadequate to serve much of Berwick and the sole reason for this system is to maintain pressure in the pipeline to avoid customer outage. Regulator B performs exactly the same function as regulator C.

If either regulator E or D should fail open and their associated monitor regulator C or B should fail to control the pressure, relief valve F would open, venting gas to the atmosphere and controlling the pipeline pressure at 400 psig. (Note: if the transmission pressure exceeds 720 psig, the sizing of valve F is such that that the pipeline pressure would reach 720 psig, which is the design working pressure of the 12" pipeline.) *The venting of the gas will present no hazard* to the Susquehanna Steam Electric Station, because natural gas vented vertically at acoustic velocity has sufficient kinetic energy to assure mixing with the surrounding air to a concentration below the Lower Flammable Limit (LFL). Furthermore, the rate of flame propagation of natural gas is so low that the jet cannot remain ignited.

The normal operation of the Shickshinny City Gate Station by PG&W is in the flow control mode. If the 12" pipeline were to suffer a major leak or break, the Station would merely continue to supply gas to the pipeline at the already set rate. Depending upon the distance between the leak or break and the station, and the pressure drop that would result from that distance, regulator D might open to maintain a pressure of 100 psig at the station.

Returning to the discussion of the Grove Flexflo regulators. The core was described as having slots with a septum dividing the upstream and downstream portions of the valve. Obviously, the number and size of those slots will establish the flow capacity of the valve (the expansion pressure of the of the tube and the setting of the external controls can also influence the overall capacity of the valve). In general, the sizing of the basic core is comparable with conventional control valves of equal line size. However, the core can be readily changed and the manufacturer offers cores with reduced capacity. Generally, the reduced capacity corresponds to the standard core of one or two smaller line sizes. For example, it is possible to use cores having the capacity of either 2" or 3" Flexflo's in the 4" Flexflo body.

The core itself is a substantial casting that is designed to withstand full differential pressure and, because of its design, it does become a fixed flow restrictor when the tube is fully inflated. Figure 1, annexed, indicates the total maximum flow through two Flexflo regulators in series with both regulators wide open. At the present time, all four regulators (B, C, D and E) have 4" cores in 4" bodies. Therefore the present capacity constraint imposed by a single pair of the existing regulators is represented by the line identified 4" x 4". This would be a realistic assumption for a simultaneous line break and total system regulator failure of the right hand pair (C and E) provided the break occurs far enough downstream to avoid the operation of regulator D.

The previously mentioned letter (June 1, 1982, Curtis to Schwencer) provides the criteria of 39 m^3/sec. break flow as the maximum rate which will not create a potential threat to the safe operation of the Susquehanna plant. In that same letter, it was estimated that the maximum backflow (from the Berwick end of the line) would be 9 m^3/sec. Thus, restricting the deliverability of the Shickshinny City Gate Station to a maximum rate of 30 m^3/sec. (3.81 M^2scf/hr.) would *eliminate the pipeline as a potential threat* to the safe operation of the Susquehanna Steam Electric Station.

The flow in the pipeline between the Gate Station and the postulated break would be extremely high. B. C. Shebeko, in the handbook which accompanies the Polyflo Flow Computer, provides a graphical solution for this problem (p. 90, copy annexed). Assuming: L = 8700 feet, P_2 = 14.73 psia, T_1 = 520° R, D = 12.188" and a calculated specific gravity = .5856, the flow versus upstream pressure has been calculated and shown in Figure 2, annexed.

It can be seen, from Figures 1 and 2, that the total wide open failure of the right hand run (regulators C and E) will deliver less than 30 m^3/sec. to the pipeline if the upstream pressure (TRANSCO) is less than 925 psig. Furthermore, the pressure drop in the pipeline will be sufficient to preclude the automatic opening of regulator D at 100 psig. However, if the upstream pressure exceeds 925 psig, or if regulator D fails open it is possible to deliver more than 30 m^3/sec. to the pipeline. It should be noted however, that the failure of regulator E, alone, will not result in a delivery in excess of 30 m^3/sec. to the pipeline.

These limitations were discussed, both at the site and later by phone, with Messrs. Taylor, Walsh and Lyle and they agreed to install 3" equivilent cores in regulators C and E and to either install 2" equvilent cores or replace regulators B and D with 2" regulators as an interim measure. Furthermore, PG&W will install a check valve, which will eliminate the 9 m^3/sec. backflow, in the 12" pipeline as near as practical to the western edge of the Susquehanna plant property prior to the restablishment of the full size cores in regulators C and E. (This will be occasioned by load growth and should occur within a couple of years.) Also, PG&W will inform PP&L of any intended changes at the Shickshinny City Gate Station which could result in increased deliverability to the Berwick pipeline. The change of regulator cores or regulators can, and will, be accomplished within a few weeks. The agreements, mentioned above, will be confirmed by an exchange of letters.

These modifications should provide both redundancy and risk reduction that should *totally eliminate the natural gas pipeline as a potential risk to the safe operation of the Susquehanna plant.* The present design of the Shickshinny City Gate Station would require at least two failures or human errors in addition to the simultaneous pipeline ruture to achieve the postulated hazard (these two additional failure events were apparently overlooked in the probabilistic anaysis submitted on January 21, 1982 in response to Question 311.1). The incorporation of the above modifications in the Shickshinny City Gate Station should have little effect upon PG&W's operations but they will physically restrict the deliverability of the Gate Station, even with multiple failures, to the extent that the postulated leak rate of 39 m^3/sec. cannot occur within the area of concern.

Sincerely,

James H. Stannard, Jr.

James H. Stannard, Jr.

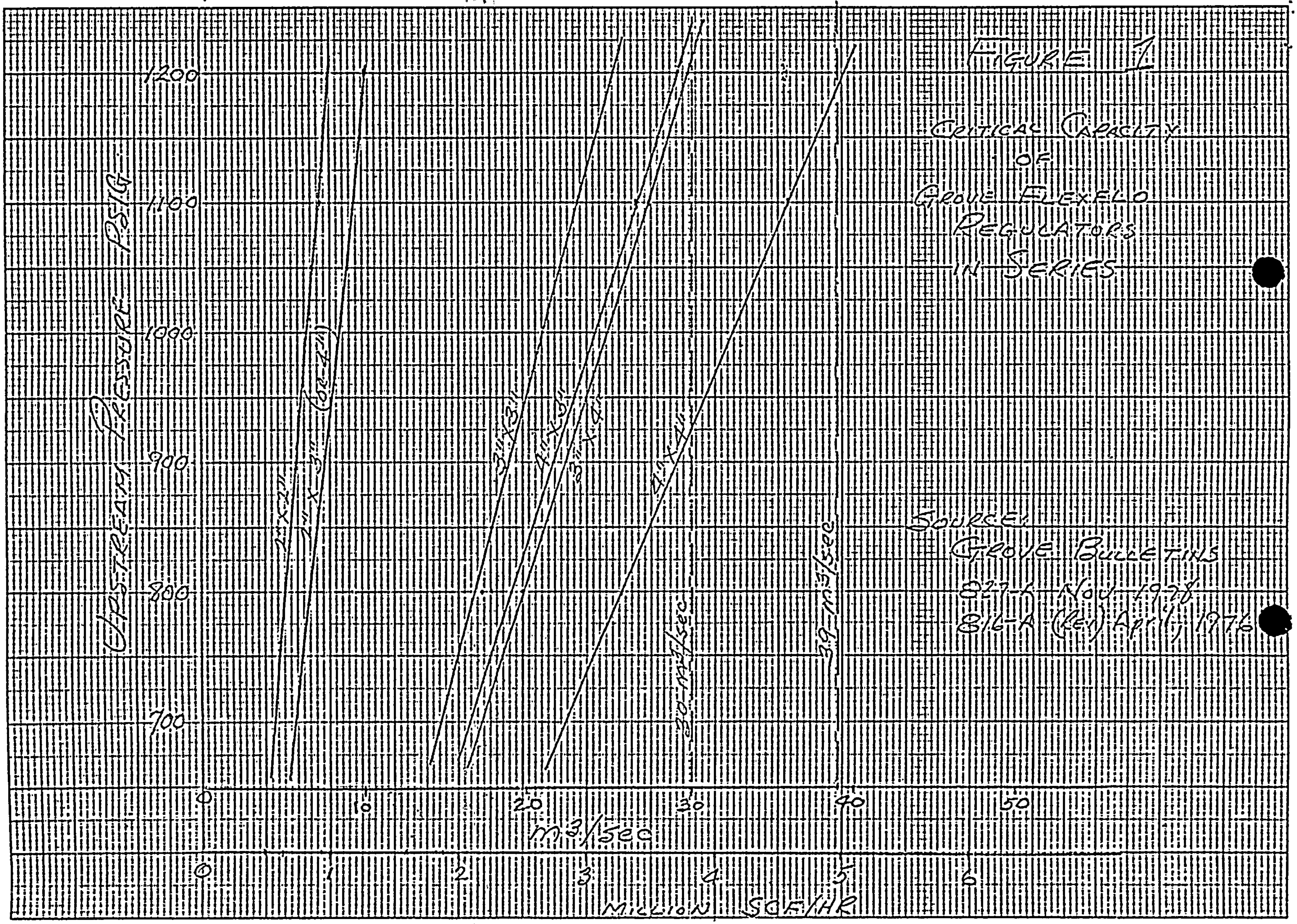


FIGURE 1
CRITICAL CAPACITY OF GROVE FLEXFLO REGULATORS IN SERIES
SOURCE: GROVE BULLETINS 827-A NOV 1978 816-A (REV) APRIL 1976
UPSTREAM PRESSURE PSIG
1200
1100
1000
900
800
700
1"X2"
1"X3"
(or 4")
3"X3"
4"X3"
3"X4"
4"X4"
30 m3/sec
39 m3/sec
0
10
20
30
40
50
m3/sec
0
1
2
3
4
5
6
MILLION SCF/HR

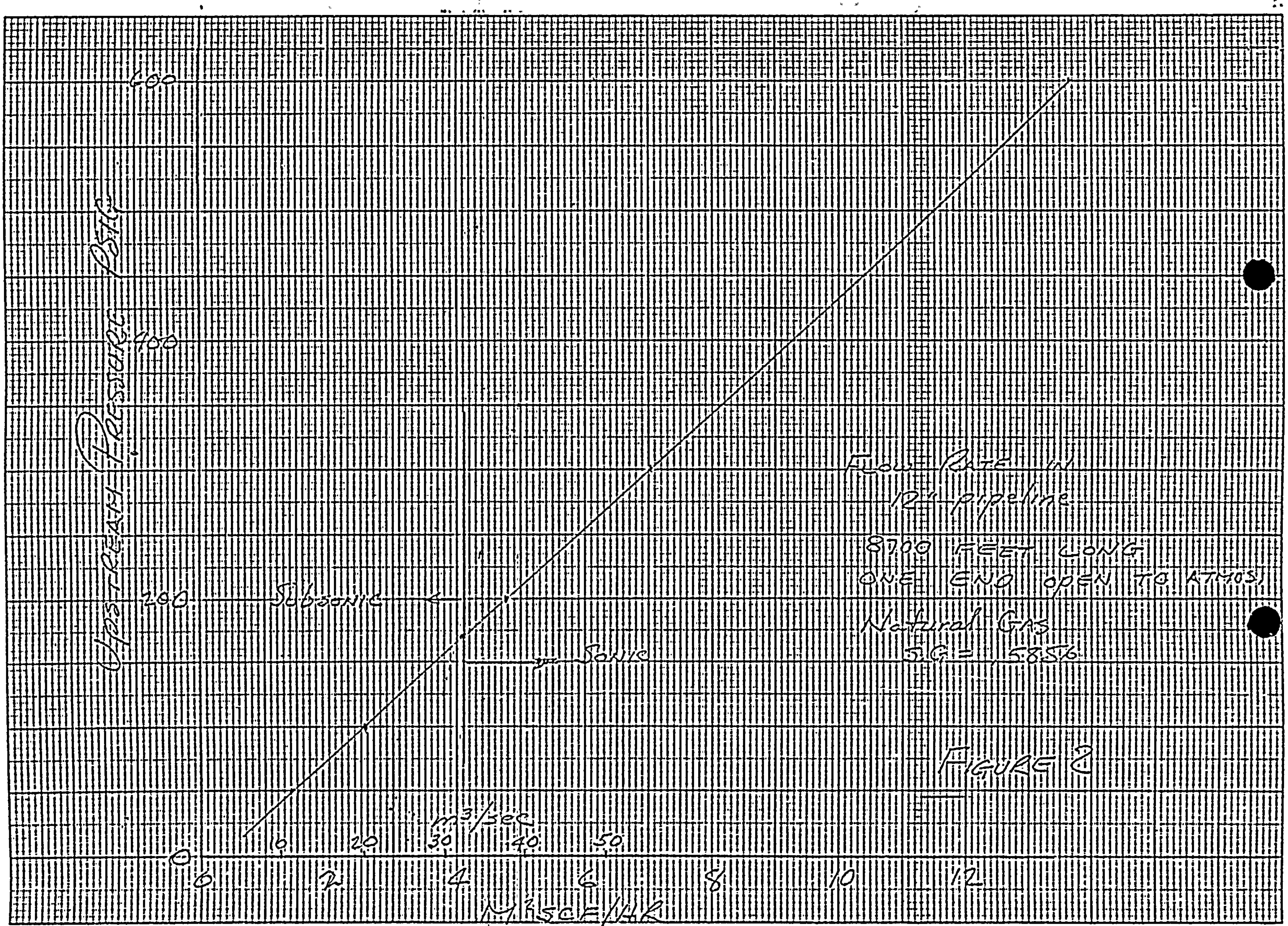

UPSTREAM PRESSURE PSIG
600
400
200
0
Subsonic
Sonic
FLOW RATE IN
12" pipeline
8700 FEET LONG
ONE END OPEN TO ATMOS.
Natural Gas
S.G = .5856
m3/sec
10
20
30
40
50
0
2
4
6
8
10
12
MMSCF/HR

FIGURE 2

FIG. 47

DISCHARGE OF NAT. GAS FROM THE OPEN END OF PIPE

P_1 = 150 PSIG

6" PIPE

P_2 = 14.73 PSIA

400'

THE NATURAL GAS OF 0.6 SP. GR. AND INITIALLY AT 60°F DISCHARGES INTO ATMOSPHERE THRU AN OPEN END OF 6" (6.065" I.D.) PIPE 400 FT LONG. FIND THE HOURLY FLOWING RATE a) WHEN THE HEADER PRESSURE IS 150 PSI AND b) WHEN THE HEADER PRESSURE IS 25 PSI.

NOTE: ASSUME 1.75 VEL. HEADS FOR VALVE RESISTANCE.

SOLUTION:

RESISTANCE IN VEL. HDS.

ENTRANCE LOSS	0.50
$V^2/2g$	1.00
VALVE	1.75
PIPE 400 × 0.0298 =	11.84
TOTAL N	= 15.09

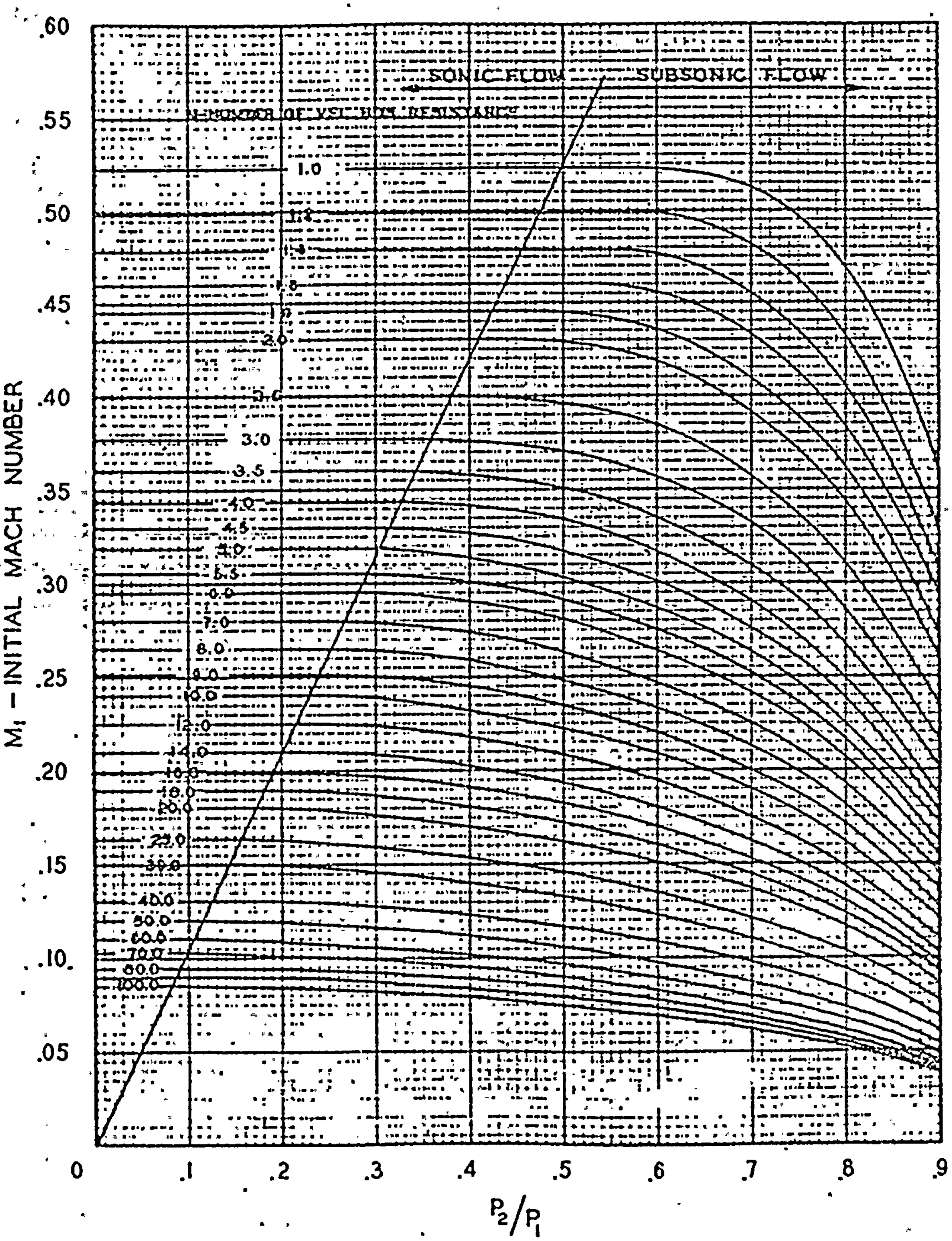
a) $P_2/P_1 = \frac{14.73}{164.73} = 0.0895$; M_1 – FROM THE CHART = 0.204

SINCE THE INTERSECTION OF P_2/P_1 WITH N-LINE OCCURS TO THE LEFT OF SLANTED LINE THE FLOW AT THE END OF PIPE IS SONIC.

$Q = 32\,700 \times 0.204 \times 164.73 \times 6.065^2 \sqrt{\frac{1}{520 \times 0.6}} = 2.27\ M^2CF/HR$

b) $P_2/P_1 = 0.372$; $M_1 = 0.20$ (FLOW AT THE END OF PIPE IS SUBSONIC)

$Q = 32\,700 \times 0.2 \times 39.73 \times 6.065^2 \sqrt{\frac{1}{520 \times 0.6}} = 0.541\ M^2CF/HR$



F-NUMBER OF VEL. HDS. RESISTANCE P. FT. OF PIPE K = 0.0018			
D	F P. FT.	D	F P. FT.
1	.258	18	.0080
1½	.150	20	.0071
2	.103	22	.0063
3	.0677	24	.0057
4	.0485	26	.0052
6	.0298	30	.0044
8	.0204	32	.0040
10	.0159	34	.0038
12	.0129	36	.0036
14	.0120	42	.0030
16	.0092	48	.0025

$Q_{HR} = 32700\, M_1 P_1 D^2 \sqrt{\frac{1}{T_1 S}}$

P_1 = UPSTREAM PRESSURE PSI ABS.

P_2 = BACK PRESSURE PSI ABS.

M_1 = INITIAL MACH NUMBER

N = TOTAL NUMBER OF VEL. HEADS RESISTANCE (F + 1)

T_1 = INITIAL ABS. TEMP. °F

D = DIAMETER OF PIPE INCH.

S = SPECIFIC GRAVITY

REFERENCE:

"COMPRESSIBLE FLUID FLOW" BY ASCHER H. SCHAPIRO